SOUTHWEST FISHERIES SCIENCE CENTER

NOAA FISHERIES - NATIONAL MARINE FISHERIES SERVICE - SOUTHWEST FISHERIES SCIENCE CENTER

JANUARY 2013

SOUTHWEST FISHERIES SCIENCE CENTER MARINE MAMMAL CRUISE REPORTS, 1974 - 1985

by

Al Jackson

ADMINISTRATIVE REPORT LJ-13-01

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National Marine Fisheries Service
National Oceanic & Atmospheric Administration
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LIST OF TABLES AND APPENDICES

Southwest Fisheries Science Center Marine Mammal Cruise Reports, 1974-1985

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Since January, 1974, the Southwest Fisheries Science Center has conducted ship-based population density surveys of cetaceans in the eastern tropical Pacific Ocean. The main impetus for these surveys was to determine whether and/or how dolphin populations were being impacted by the yellowfin tuna purse seine fishery. In 1979, in response to concerns over the incidental take of marine mammals in the coastal drift and set gillnet fisheries, the first marine mammal survey within the California Current was conducted to estimate the abundance of all cetacean species. The purpose of this report is to reproduce and preserve the "cruise reports" that documented the methods and very preliminary results of these cruises from 1974 to 1985. After 1985, SWFSC marine mammal cruises are more thoroughly described in formal reports published as NOAA Technical Memoranda.

The cruise report, a brief description of the main aspects of a cruise, is usually issued a few days or weeks after a cruise is completed. The format and content of the cruise report changed somewhat over the years, but it typically contains the name of the vessel, the primary objectives of the cruise, dates, port calls, procedures, preliminary results, scientific personnel and disposition of data. There are different types of cruises represented in this collection of cruise reports. Some cruises are line-transect surveys designed to collect data in order to make estimates of abundance. Other cruises were designed to study cetacean behavior. Still other cruises were conducted primarily for some other purpose, e. g., oceanographic studies, but provided a platform of opportunity to collect cetacean sighting information. The SWFSC marine mammal cruises from 1974 to 1985 are listed chronologically in Table 1

The information contained in the cruise report, especially the results of the cruise, is preliminary and is subject to revisions. A more detailed and comprehensive report of cruise methods and results is contained in the "data report" that is issued as a NMFS Technical Memorandum, but such reports were routinely issued only for cruises after 1981. For four cruises, a cruise report either does not exist or could not be located, but the basic cruise information can at least partially be gleaned from other reports.[1]

[1] No cruise reports could be located for Cruises 0125, 0215, 0412 and 1644. Accounts of these cruises can be found in other reports cited in Appendix 1.

Some of the information contained in the cruise report may not be found elsewhere, not even in the primary data sets. For example, the vessel name, locations of port calls, cruise objectives and procedures that are typically provided in the cruise report are not included in the searching effort and sightings data set, the so-called “das” data. For cruises before 1982, the identities of participating scientists/observers are not contained in the “das” data but are included in the cruise report. Copies of original cruise reports for SWFSC marine mammal cruises from 1974 to 1985 are provided in Appendix 2. These cruise reports, when used in conjunction with reports by Tim Lee (1993) and Douglas Kinzey et al. (2000), provide an overview of SWFSC marine mammal cruise operations and results similar to that provided by the formal data reports issued for later cruises.

Literature Cited

Kinzey, Douglas, P. Olson and T. Gerrodette. 2000. Marine mammal data collection procedures on research ship line-transect surveys by the Southwest Fisheries Science Center. Administrative Report. LJ-00-07C.

Lee, Timothy. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985. NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-181.

Table 1. A chronological list of all SWFSC marine mammal research cruises from 1974 – 1985.

Cruise	Date Depart	Date Return	Vessel	Region	Primary Objective	Chief Scientist
0084	02-Jan-74	26-Feb-74	*D. S. Jordan*	Eastern Tropical Pacific	Dolphin Distribution	Smith, T.
0126	01-Feb-75	01-Apr-75	*Vnushitelny*	Eastern Tropical Pacific	Soviet-U.S. Whale Tagging	Evans, W.
0168	05-Jan-76	03-Mar-76	*Cromwell*	Eastern Tropical Pacific	Dolphin Distribution	Au, D.
0169	05-Jan-76	02-Mar-76	*D. S. Jordan*	Eastern Tropical Pacific	Dolphin Distribution	Barham, E.
0216	19-Jul-76	26-Aug-76	*Oceanographer*	Eastern Tropical Pacific	Deep Ocean Mining Environmental Study	Perryman, W.
0207	05-Oct-76	18-Nov-76	*D. S. Jordan*	Eastern Tropical Pacific	Behavior (Tuna-Dolphin Bond)	Holts, D.
0208	11-Oct-76	09-Dec-76	*Elizabeth C. J.*	Eastern Tropical Pacific	Fishing Gear to Reduce Dolphin Kill	Coe, J.
0215	11-Oct-76	09-Dec-76	Helicopter (*Elizabeth C. J.*)	Eastern Tropical Pacific	Dolphin Behavior	Coe, J.
0212	15-Nov-76	09-Dec-76	*Surveyor*	Eastern Tropical Pacific	School Size Calibration/Dolphin Avoidance	Au, D.
0213	04-Jan-77	08-Mar-77	*D. S. Jordan*	Eastern Tropical Pacific	Dolphin Distribution	Au, D.
0214	06-Jan-77	25-Mar-77	*Cromwell*	Eastern Tropical Pacific	Dolphin Distribution	Perryman, W.
0232	24-Mar-77	15-Apr-77	*Oceanographer*	Eastern Tropical Pacific	Deep Ocean Mining Environmental Study	Lambert, J.
0234	06-Apr-77	02-May-77	*Zharkii*	Western Pacific	Soviet-U.S. Whale Tagging/Observation	Birk, S.
0310	27-Jun-77	29-Jul-77	*Oceanographer*	Eastern Tropical Pacific	Deep Ocean Mining Environmental Study	Lambert, J.
0319	03-Oct-77	21-Nov-77	*Jordan*	Eastern Tropical Pacific	Dolphin Distribution and Equatorial Front	Au, D.
0412	16-Jan-78	13-May-78	*Mary K.*	Eastern Tropical Pacific	IATTC Tuna-Tagging	Orange, C.
0428	02-Aug-78	29-Sep-78	*Regina Maris*	Eastern Tropical Pacific	Behavior of Undisturbed Dolphin Schools	Stuntz, W.
0463	03-Jan-79	15-Mar-79	*D. S. Jordan*	Eastern Tropical Pacific	Calibration/Dolphin Population Assessment	Au, D.
0464	03-Jan-79	15-Mar-79	*Cromwell*	Eastern Tropical Pacific	Calibration/Dolphin Population Assessment	Au, D.
0564	27-Sep-79	24-Oct-79	*D. S. Jordan*	California Current	Cetacean Density/Movement Patterns	Au, D.
0598	03-Jan-80	05-Mar-80	*D. S. Jordan*	Eastern Tropical Pacific	Dolphin Population Assessment	Au, D.
0599	03-Jan-80	05-Mar-80	*Cromwell*	Eastern Tropical Pacific	Dolphin Population Assessment	Au, D.
0642	21-Mar-80	19-Apr-80	*Oceanographer*	Eastern Tropical Pacific	Equatorial Pacific Ocean Climate Studies	Au, D.
0646	17-Jun-80	11-Jul-80	*D. S. Jordan*	California Current	Marine Mammal Population Assessment	Au, D.
0648	21-Jul-80	25-Sep-80	*Researcher*	Eastern Tropical Pacific	Equatorial Pacific Ocean Climate Studies	Au, D.

Table 1. A chronological list of all SWFSC marine mammal research cruises from 1974 – 1985. (Continued)

Cruise	**Date Depart**	**Date Return**	**Vessel**	**Region**	**Primary Objective**	**Chief Scientist**
0687	20-Jan-81	01-Apr-81	*Oceanographer*	Eastern Tropical Pacific	Equatorial Pacific Ocean Climate Studies	Au, D.
0716	19-May-81	29-Jul-81	*Oceanographer*	Eastern Tropical Pacific	Equatorial Pacific Ocean Climate Studies	Au, D.
0798	05-Apr-82	22-Apr-82	*D. S. Jordan*	California Current	Sighting Methodology/Pilot Whale Survey	Holt, R.
0801	15-May-82	03-Aug-82	*D. S. Jordan*	Eastern Tropical Pacific	Dolphin Population Assessment	Holt, R.
0843	12-Jan-83	13-Apr-83	*D. S. Jordan*	Eastern Tropical Pacific	Dolphin Population Assessment	Holt, R.
0852	03-Mar-83	11-Apr-83	*Surveyor*	Eastern Tropical Pacific	Dolphin Avoidance Experiment	Hewitt, R.
1644	06-Oct-83	06-Dec-83	*Discoverer*	Eastern Tropical Pacific	Equatorial Pacific Ocean Climate Studies	Pitman, R.
0874	05-Dec-83	11-Dec-83	*D. S. Jordan*	California Current	Pilot Whale Survey	Hohn, A.
0893	08-Aug-84	28-Aug-84	*D. S. Jordan*	California Current	Albacore Population Dynamics	Bartoo, N.
0895	04-Sep-84	15-Sep-84	*D. S. Jordan*	California Current	Harbor Porpoise Survey	Barlow, J.
0905	05-Dec-84	19-Dec-84	*D. S. Jordan*	California Current	Pilot Whale Survey	Hohn, A.
0910	24-Jan-85	09-Feb-85	*McArthur*	California Current	Harbor Porpoise Survey	Barlow, J.
0942	03-Sep-85	17-Sep-85	*D. S. Jordan*	California Current	Harbor Porpoise Survey	Barlow, J.

Appendix 1. Other reports describing SWFSC marine mammal cruises for which cruise reports could not be located.

Cruise 0126: Berzin, A. A. 1978. Whale distribution in tropical eastern Pacific waters. Report of the International Whaling Commission 28:173-177.

Cruise 0215: Norris, K. S., W. E. Stuntz and W. Rogers. 1978. The behavior of porpoises and tuna in the eastern tropical Pacific yellowfin tuna fishery - preliminary studies. Final report, U. S. Marine Mammal Commission Contract MM6AC022 to Center for Coastal Marine Studies, University of California, Santa Cruz. NTIS PB 283 970.

Cruise 0412: Bayliff, W. H., and G. A. Hunt. 1981. Exploratory fishing for tunas and tuna tagging in the Marquesas,Tuamotu, Society, Pitcairn, and Gambier Islands. Inter-American Tropical Tuna Commission Special Report 3.

Cruise 1644: Pitman, R. 1984. Report of Multispecies Assessment Task research cruise in the eastern/central tropical Pacific, October 6 - December 6, 1983 (Cruise No. RP-9-DI-84, NOAA Ship Discoverer). Southwest Fisheries Science Center Administrative Report LJ-84-43.

Appendix 2A. Cruise report for SWFSC Cruise 0084.

UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
La Jolla, California 92037

CRUISE REPORT NO. 84

VESSEL:	R/V *David Starr Jordan*, Cruise No. 84			
CRUISE PERIOD:	January 2 to February 26, 1974			
ITINERARY:	Depart:	San Diego	1600	January 2, 1974
		Commence marine mammal watch off Cabo San Lucas. Work in the eastern tropical Pacific		
	Arrive:	Rodman Naval Base, Panama	0600	January 20, 1974
	Depart:	Rodman Naval Base, Panama	0900	January 26, 1974
	Arrive:	San Diego	1300	February 26, 1974

CHIEF SCIENTIST: Jack Metoyer
Southwest Fisheries Center
P.O. Box 271
La Jolla, California 92132

PRINCIPAL INVESTIGATOR: Dr. Tim Smith
Southwest Fisheries Center
P.O. Box 271
La Jolla, California 92132

RESULTS: I. Biology: Porpoise density survey.

1. Effort (hours observing) - 317 hours
2. Nautical miles observed - 3,700 nautical miles

Appendix 2A. Cruise report for SWFSC Cruise 0084. (Continued)

4. Sightings:

Species	# Sightings
Spotters	5
Spinners	5
Mixed - Spotter/spinner	8
Delphinus	6
Unidentified porpoise	17
Streaked porpoise	8
Tursiops	1
Lagenodelphis	2
Other marine mammal sightings	42
Tuna purse seiners	3

5. Deep scattering layer: continuous monitoring by EH-3 sounder.

II. Hydro cast

1. Deep hydro casts: (to bottom) 20 bottles, 5 stations.

2. STD casts (1000 m): 20 bottles, 5 stations.

3. Bathythermograph: XBT (0600 and 1800 hours) - 96 observations.

4. Daily weather observations - 51 days.

EQUIPMENT MALFUNCTION AND OTHER PROBLEMS:

1. 20 x 120 mm binoculars seal broken causing internal condensation. Two days of observations lost.

2. XBT - calibration problems.

3. Starboard engine problems - slowed progress.

4. One of the ship's personnel stricken ill February 25, 1974. Aborted two deep hydro cast stations and porpoise observation leg from 7°N, 123°W to 10°N, 145°W.

Appendix 2A. Cruise report for SWFSC Cruise 0084. (Continued)

DISTRIBUTION OF DATA AND SAMPLES:	1.	Bathythermograph (XBT)	Forrest Miller	SWFC-NMFS
	2.	Deep scattering layer	Paul Smith	SWFC-NMFS
	3.	Hydro cast stations	Ron Lynn	SWFC-NMFS
	4.	Porpoise data	Tim Smith	SWFC-NMFS

SCIENTIFIC PERSONNEL:

Metoyer, Jack, Biological Technician, SWFC-NMFS.

Reilly, Steve, Porpoise Observer, SWFC-NMFS.

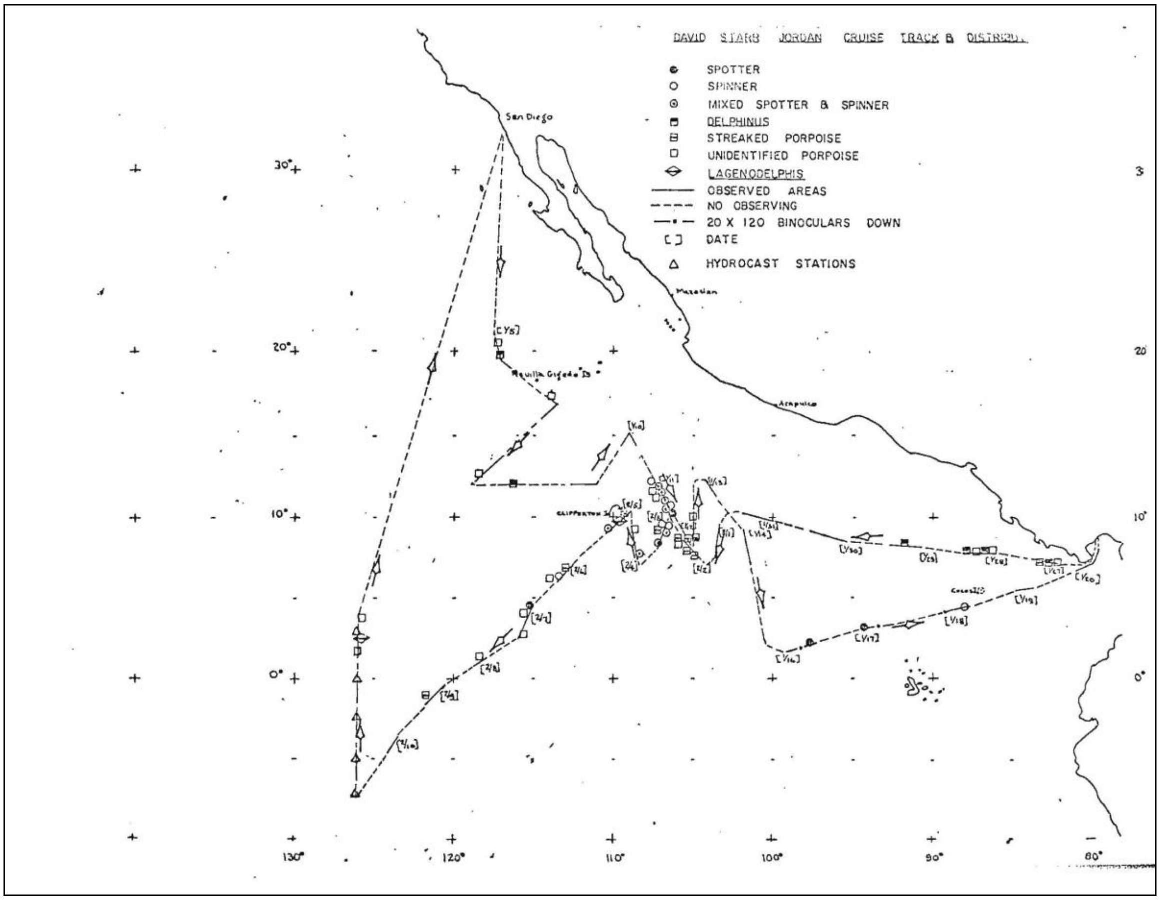
Sexton, Ken, Porpoise Observer, SWFC-NMFS

The porpoise data will be incorporated with other information to estimate the size of porpoise stocks in the eastern tropical Pacific.

5-9-74
Date

Prepared by: [signature]
Jack Metoyer

Appendix 2A. Cruise report for SWFSC Cruise 0084. (Continued)



Appendix 2B. Cruise report for SWFSC Cruise 0168.

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

CRUISE REPORT Cr# 168

VESSEL: NOAA Ship Townsend Cromwell

CRUISE PERIOD: Cruise No. 68; January 5 to March 3, 1976

ITINERARY:
Depart Honolulu: January 5
Arrive Wreck Bay, San Cristobal, Galapagos Islands: January 30
Depart Wreck Bay: February 2
Arrive Chatham Bay, Cocos Islands: February 4
Depart Cocos Islands: February 4
Refuel at Puntarenas, Costa Rica: February 6
Depart Puntarenas: February 11
Arrive San Diego: March 3

OBJECTIVES: The primary purpose of this survey was to determine the boundaries of porpoise populations that are involved in the eastern tropical Pacific tuna fishery. The distribution of all porpoise species and other marine mammals were to be studied. The cruise track was designed to investigate the little-known western and southern boundaries and the relationships of the populations to environmental variables associated with divergence and convergence areas of the equatorial currents, and to island effects. This survey was conducted jointly with NOAA Ship David Starr Jordan (Jordan Cruise 100, January 5 to March 2, 1976), whose track supplemented that of Cromwell.

OPERATIONS: During daylight hours the waters along the ship's track were visually searched for marine mammals, using mounted 20-power, 120-mm spotting and hand-held 7 X 50 binoculars. An observer, standing 3-hour watches, was stationed on each outside wing of the ship's bridge, where the binoculars were mounted. All sightings of birds and mammals were recorded. On almost all mammal sightings the ship deviated from its course and approached or chased the school until identification was made. Photographs were taken when possible. An average of 124 nautical miles were searched each day, totalling 506 hours of observation for the 9240-mile cruise.

XBT's were cast approximately each 50 miles along the cruise track (Figure 1). Surface salinity samples were taken at each XBT station. The thermosalinograph recorder was operated continuously during the cruise.

Twenty-seven, 1-hour hauls with the 100' X 100' Cobb trawl ( ) were made at 2000 hours, or approximately 2 hours after sunset, at various locations along the track (Figure 1). The trawl was deployed at 25 fm/min until 125 fm of wire was out, then retrieved each 5 minutes in 25 fm increments at 10 fm/min. Specimens obtained were preserved for investigators at SWFC.

Following each trawl station, 1 hour was spent jigging for squid, using the ship's deck lights to attract the animals. The most effective fishing was by use of small squid lures, with barbless hooks, cast out and retrieved with rod and reel.

Three feathered jigs were trolled from the ship's stern during daylight hours. In general the ship's speed was too great for effective fishing of this type. Fish caught were measured and stomach contents noted and recorded.

RESULTS: One hundred and eight porpoise and whale sightings were recorded (Figure 2, Table 1). Fifty-two of these were whale sightings (Figure 3, Table 1).

The porpoise schools were encountered in greatest frequency between the Galapagos Islands and 108°W, especially along the equator. In this region the thermocline depth was shallow (cu. 20 m) and Peru Current and tropical waters meet. Twenty-one whale sightings also occurred in this area, including an estimated 38 sperm whales in three groups. Most of the porpoise schools were streaker porpoise (*Stenella coeruleoalba*, 13 sightings). Other species seen included the common dolphin (*Delphinus delphis*, ~~3~~ three schools), spotted porpoise (*Stenella attenuata*, 4 schools) and Frazer's porpoise (Lagenodelphis hosei, one school). All the streaker porpoise were in schools of less than 100 animals, and six of the schools contained less than 50 individuals. The common dolphin schools ranged from 70 to 225 individuals, the spotters, between 50 and 60 individuals and the single school of Frazer's porpoise had about 200 animals. None of the schools were associated with birds, nor were fish seen beneath them. These sightings, particularly that of common and streaker porpoise represent westward extensions of known range along the equator.

The second area of abundant porpoise schools lay between Cocos Island and Puntarenas where eight sightings occurred. Except for one Delphinus school these were all streaker porpoise. They were small schools again, none exceeding 100 individuals. Birds were abundant in this area, and rafts of several thousand wedge-tailed shearwaters (Puffinus pacificus) were seen. Bird activity was associated with numerous surface convergence lines rather than with the porpoise schools.

Porpoise sightings along other portions of the cruise track were relatively sparse. Ten sightings were recorded between Puntarenas and Clipperton Island. These porpoise were in small schools and most could not be identified.

They fled the ship quickly and with little jumping. One school was associated with birds exhibiting feeding behavior over it.

Four porpoise schools with estimated numbers greater than 500 were seen. One was an unidentified school just north of the Galapagos Islands, the other three were spinner and mixed spinner-spotter schools. The spinner (S. longirostris, whitebelly type) were first seen at 11°35'N, 146°33'W, a school of about 500 animals in association with 75-100 sooty terns (Sterna fuscata). Next, two schools of the same type were seen at approximately 4°S, 113°W, the first with about 500 animals, the second, a mixed school of spotters and spinners, with about 2000 animals total. These last sightings extend also the known westward extension of range along the equator for spinner porpoise.

Cromwell was not able to go far enough south to determine the southern hemisphere boundary of equatorial porpoise distribution, particularly in the region south of the Galapagos Islands. But sightings along the track west of the Galapagos suggest sparse populations in the deeper thermocline (>50 m mixed layer) waters beyond the area of eastern tropical surface water.

Bird sightings in the above deep-thermocline waters were primarily of sooty terns, petrels (Pterodroma sp.), wedge-tailed shearwaters, and storm petrels Oceanodroma sp.). Bird flocks were scattered throughout this area (Figure 4). Along the equator no flocks were seen, and only storm petrels were common. Around islands and near the continent, boobies (Sula sp.), wedge-tailed shearwaters, and terns were numerous. Between Puntarenas and Clipperton Island relatively few shearwaters and petrels were seen. To the west of Clipperton in waters of deeper thermocline these species were more abundant again.

Squid were more abundant about the ship along the equator and west of 100°W. Few squid were taken, however, the lures used not being very effective. Most were of the species Symplectoteuthis oualaniensis.

No fishing vessels were encountered except near ports. However during the time of this cruise there was active tuna-porpoise fishing to the north and south of the Galapagos Islands, areas not intersected by the Cromwell track.

PROBLEMS AND RECOMMENDATIONS: The area surveyed by the two ships, Cromwell and Jordan is so vast that even two ships are inadequate. Even the 60 days allotted did not allow enough time to investigate all the areas of interest either planned or suggested by on-going cruise results. Nevertheless, these surface surveys are useful, particularly in seeking answers to specific questions. Research ships with their long range and endurance capabilities afford many opportunities to obtain a variety of observations, measurements, and samples from the sea.

Porpoise were detected by a combination of unaided eye, hand-held binoculars, and mounted 20-power spotting binoculars. The latter was effective in searching the horizon (about 6 miles distant on Cromwell), but it also introduces confounding factors into estimates of area searched and effectiveness of effort. This is because the ability to detect mammals near the horizon is greatly affected by wind-generated shitecaps, by the rolling and pitching of the vessel, and by wind buffeting of the binoculars. This means that any windspeed in excess of 10 knots will alter greatly the effective area searched. These speeds are common in the trade wind belts, particularly in the regions west of the "doldrums."

Haze which was encountered at the equator and near the coast, associated with warm breezes over cool water, also reduces horizon visibility. Birds over schools that enable porpoise detection, even over the horizon, also is a variable because the likelihood of association with a certain mammal species varies according to the abundance and species of birds in different oceanographic regimes. All these factors and others can alter the area of effective search radically and quickly. Much thought must go into the design of new mammal watch logs that require regular input of scaled descriptions of such variables so that attempts at quantifying search can be made. Until then it will be difficult to use mammal sighting records to estimate densities with confidence.

Biological sampling was at a minimum on this cruise, the major effort being daylight, visual searching. Nighttime sampling by Cobb trawl and squid jigging was reduced due to cancellations needed in order to make up time on the cruise schedule. Furthermore, this sampling was ineffective, judging by the poor catches. Yet biological sampling designed to better understand epipelagic trophic relationships, important in tuna-porpoise-bird interactions, are much needed. To this end future cruises

Appendix 2B. Cruise report for SWFSC Cruise 0168. (Continued)

should implement workable systems to obtain samples for studies of distribution of neuston and surface layer nekton, flying fish species, squid, and birds. Specimens of the latter two for examination are especially needed.

Movie sequences of marine mammals should be a requirement for each cruise. The present method of taking snapshots is inadequate for fast moving animals. Such footage will be valuable for both observer training and biological studies.

On this cruise Cromwell rendezvousued with Jordan twice. This should be minimized on future cruises in order to maximize the flexibility of each vessel to carry out investigations within the allotted cruise time.

SUMMARY OF THE DATA COLLECTED:	Mammal Sightings	
	Porpoise	56
	Whales	52
	XBT casts	194
	Cobb trawls	27
	Squid stations	27

SCIENTIFIC
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Gary Friedrichsen, Biological Technician (Temp.), SWFC, NMFS
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Phillip Unitt, Biological Technician (Temp.), SWFC, NMFS

Date________________________________ Prepared by____________________________
David W.K. Au
Operations Research Analyst
Chief Scientist

Approved by____________________________
Izadore Barrett

Appendix 2B. Cruise report for SWFSC Cruise 0168. (Continued)

Marine Mammal Sightings, Townsend Cromwell - 68

Date	Position	Mammal	Number
9 Jan	11°35'N 146°33'W	Unid. Large Whale	2±1
9 Jan	11°35'N 146°33'W	Stenella longirostris	500±200
10 Jan	09°50'N 144°15'W	Unid. Large Whale	1
10 Jan	09°46'N 143°51'W	Balaenoptera physalus	2±1
13 Jan	05°00'N 138°24'W	Unid. Medium Whale	1
13 Jan	04°48'N 138°15'W	Unid. Small Whale	1
14 Jan	01°25'N 137°42'W	Orcinusorca	2
19 Jan	00°00' 125°12'W	Pseudorca crassidens	20±10
19 Jan	00°00' 125°12'W	Unid. Large Baleen Whale	1
20 Jan	00°17'N 122°45'W	Unid. Large Whale	2±1
20 Jan	00°22'N 122°13'W	Unid. Small Whale	2
20 Jan	00°27'N 120°55'W	Balaenoptera borealis	2
21 Jan	00°00'N 118°41'W	Unid. Large Whale	1
22 Jan	02°25'S 116°09'W	Globicephala macrorhyncha	1
22 Jan	03°20'S 115°29'W	Physeter catodon	3±1
23 Jan	04°03'S 113°15'W	Stenella longirostris	500±200
23 Jan	03°47'S 112°40'W	Stenella longirostris Stenella attenuata	2000±500
25 Jan	00°49'N 107°30'W	Stenella caeruleoalba	75±25
25 Jan	00°40'N 106°55'W	Stenella caeruleoalba	75±25
25 Jan	00°38'N 106°45'W	Delphinus delphis	125±25
25 Jan	00°37'N 106°44'W	Balaenoptera physalus/borealis	2

Appendix 2B. Cruise report for SWFSC Cruise 0168. (Continued)

Date	Position	Mammal	Number
25 Jan	00°31'N 106°20'W	Unid. Small Whale	1
26 Jan	00°05'N 104°10'W	*Stenella caeruleoalba*	30±5
26 Jan	00°05'N 104°10'W	*Stenella attenuata*	60±15
26 Jan	00°05'N 104°10'W	Unid. Large Whale	1
26 Jan	00°05'N 104°10'W	*Stenella attenuata*	50±10
26 Jan	00°16'S 102°35'W	*Stenella caeruleoalba*	60±20
26 Jan	00°16'S 102°35'W	*Balaenoptera borealis*	2
26 Jan	00°16'S 102°35'W	*Balaenoptera borealis*	1±2
26 Jan	00°16'S 102°35'W	Unid. Medium Whale	2
27 Jan	00°41'S 100°45'W	Unid. Large Whale	1
27 Jan	00°41'S 100°45'W	*Stenella caeruleoalba*	50±20
27 Jan	00°41'S 100°45'W	*Delphinus delphis*	150±30
27 Jan	00°41'S 100°45'W	*Globicephala macrorhyncha*	15±5
27 Jan	00°41'S 100°45'W	*Balaenoptera physalus*	2
27 Jan	00°41'S 100°45'W	*Globicephala macrorhyncha*	25±5
27 Jan	00°41'S 100°45'W	*Stenella caeruleoalba*	30±10
27 Jan	00°41'S 100°45'W	*Balaenoptera sp.*	1
27 Jan	00°41'S 100°45'W	*Balaenoptera sp.*	1
27 Jan	00°41'S 100°45'W	*Delphinus delphis*	70±20
27 Jan	00°41'S 100°45'W	*Stenella caeruleoalba*	50±100
27 Jan	00°41'S 100°45'W	*Physeter catodon*	30±10
27 Jan	00°41'S 100°45'W	*Globicephala macrorhyncha*	30±10

Appendix 2B. Cruise report for SWFSC Cruise 0168. (Continued)

Date	Position	Mammal	Number
27 Jan	00°45'S 100°25'W	Unid. Medium Whale	1
27 Jan	00°45'S 100°25'W	Globicephala macrorhyncha	25±5
27 Jan	00°45'S 100°25'W	Delphinus delphis	225±25
27 Jan	00°45'S 100°25'W	Stenella caeruleoalba	25±5
27 Jan	00°45'S 100°25'W	Globicephala macrorhyncha	10±5
27 Jan	00°45'S 100°25'W	Unid. Large Whale	1
27 Jan	00°45'S 100°25'W	Physeter catodon	6±1
27 Jan	00°49'S 100°00'W	Lagenodelphis hosei	200±25
27 Jan	00°49'S 100°00'W	Stenella caeruleoalba	50±10
27 Jan	00°49'S 100°00'W	Balaenoptera sp.	2±1
27 Jan	00°56'S 99°43'W	Physeter catodon	2
27 Jan	00°56'S 99°43'W	Stenella caeruleoalba	15±5
27 Jan	00°56'S 99°43'W	Stenella caeruleoalba	60±10
28 Jan	03°06'S 97°20'W	Globicephala macrorhyncha	20±5
29 Jan	02°40'S 94°16'W	Stenella caeruleoalba	20±10
29 Jan	02°40'S 94°16'W	Tursiops truncatus	20±5
29 Jan	02°40'S 94°16'W	Stenella attenuata	75±20
29 Jan	02°40'S 94°16'W	Unid. Porpoise	3
29 Jan	02°40'S 94°16'W	Mesoplodon sp.	3
29 Jan	02°40'S 94°16'W	Unid. Porpoise	10±2
29 Jan	02°24'S 93°43'W	Stenella caeruleoalba	7±2
29 Jan	02°24'S 93°43'W	Stenella attenuata	25±5

Appendix 2B. Cruise report for SWFSC Cruise 0168. (Continued)

Date	Position		Mammal	Number
29 Jan	02°24'S	93°43'W	*Stenella attenuata*	10±3
30 Jan	01°09'S	91°05'W	*Tursiops truncatus*	7±1
30 Jan	01°05'S	90°45'W	*Balaenoptera borealis*	1
30 Jan	01°02'S	90°20'W	*Tursiops truncatus*	10±5
30 Jan	01°00'S	90°07'W	*Tursiops truncatus*	7±1
2 Feb	00°29'S	89°27'W	*Mesoplodon sp.*	3
2 Feb	00°15'S	89°22'W	Unid. Porpoise	750±250
2 Feb	00°08'S	89°20'W	*Tursiops truncatus*	15±2
3 Feb	03°15'N	88°19'W	Unid. Large Whale	3±1
3 Feb	03°15'N	88°19'W	*Globicephala macrorhyncha*	4±1
5 Feb	07°12'N	86°10'W	Unid. Large Whale	1
5 Feb	07°15'N	86°09'W	*Stenella caeruleoalba*	40±10
5 Feb	07°34'N	86°00'W	*Stenella caeruleoalba*	60±10
5 Feb	07°42'N	85°55'W	Unid. Porpoise	10±5
5 Feb	07°50'N	85°52'W	*Balaenoptera borealis*	2
5 Feb	07°50'N	85°52'W	Unid. Large Baleen Whale	1
5 Feb	08°18'N	85°38'W	*Globicephala macrorhyncha*	35±5
5 Feb	08°22'N	85°35'W	*Delphinus Delphis*	80±30
5 Feb	08°32'N	85°30'W	*Stenella caeruleoalba*	50±10
5 Feb	08°47'N	85°25'W	*Stenella caeruleoalba*	15±5
5 Feb	08°53'N	85°22'W	*Balaenoptera sp.*	2±1

Appendix 2B. Cruise report for SWFSC Cruise 0168. (Continued)

Date	Position		Mammal	Number
6 Feb	09°45'N	84°48'W	Unid. Porpoise	6
11 Feb	09°47'N	84°49'W	*Stenella attenuata*	15±5
13 Feb	09°41'N	92°31'W	Unid. Porpoise	60±20
13 Feb	09°41'N	92°31'W	Unid. Large Whale	2
13 Feb	09°42'N	92°45'W	*Balaenoptera musculus*	1
13 Feb	09°42'N	92°45'W	*Balaenoptera musculus*	4±1
13 Feb	09°42'N	93°00'W	*Balaenoptera musculus*	1
13 Feb	09°45'N	94°02'W	*Stenella longirostris*	15±5
13 Feb	09°45'N	94°02'W	*Tursiops truncatus*	15±5
14 Feb	09°53'N	96°36'W	Unid. Porpoise	25±10
14 Feb	09°55'N	97°55'W	Unid. Porpoise	2
14 Feb	09°55'N	98°15'W	Unid. Porpoise	75±20
14 Feb	09°55'N	98°25'W	*Grampus griseus*	6±1
14 Feb	10°00'N	98°55'W	Unid. Porpoise	
15 Feb	10°08'N	101°41'W	*Stenella attenuata*	5
15 Feb	10°11'N	102°42'W	Unid. Porpoise	1
15 Feb	10°12'N	103°00'W	Unid. Porpoise	2±50
17 Feb	10°16'N	109°09'W	*Tursiops truncatus*	8±2
18 Feb	08°16'N	113°25'W	*Stenella caeruleoalba*	12±3
18 Feb	08°10'N	113°39'W	Unid. Large Whale	1
19 Feb	10°08'N	116°47'W	Unid. Large Whale	1
24 Feb	12°44'N	133°14'W	*Tursiops truncatus*	2±2

Appendix 2B. Cruise report for SWFSC Cruise 0168. (Continued)

Date	Position	Mammal	Number
24 Feb	13°44'N 133°14'W	*Physeter catodon*	7±1
28 Feb	24°05'N 122°20'W	Unid. Medium Whale	1
29 Feb	27°35'N 119°19'W	*Delphinus delphis*	45±10
2 Mar	30°35'N 117°47'W	*Delphinus delphis*	20±5
2 Mar	31°20'N 117°36'W	*Grampus griseus*	15±5
2 Mar	32°09'N 117°23'W	Unid. Porpoise	5±1

Appendix 2C. Cruise report for SWFSC Cruise 0169.

U.S. DEPARTMENT OF COMMERCE
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
La Jolla, California 92038

CRUISE REPORT

VESSEL: R/V David Starr Jordan, Cruise J-76-1 (100), Porpoise Cruise No. 169

CRUISE PERIOD: January 5 - March 2, 1976

ITINERARY:
Depart San Diego, January 5, 1976
Arrive San Cristobal, Wreck Bay, Galapagos Islands, January 30, 1976
Depart San Cristobal, January 31, 1976
Arrive Cocos Island, February 2, 1976
Depart Cocos Island, February 3, 1976
Arrive Puntarenas, Costa Rica, February 4, 1976
Depart Puntarenas, February 10, 1976
Arrive San Diego, March 2, 1976

OBJECTIVES:

1. Using search methods similar to those employed in the commercial tuna fishery, survey the suspected boundaries of offshore porpoise populations in the eastern tropical Pacific.
2. In particular, investigate porpoise distribution along regions of divergence and convergence of the equatorial currents and near oceanic islands.
3. To the degree possible, identify to species all marine mammal sightings and estimate their numbers.
4. Note associations of birds and fishes with these populations.
5. For possible correlation of marine mammal observations with environmental parameters, measure the thermal and salinity regime by: (a) a series of XBT probes; (b) surface salinity samples; (c) continuous temperature-salinity recordings.
6. To the degree possible, identify and record the distribution of all marine birds and collect bird specimens.
7. Make nightly neuston hauls and Isaacs-Kidd midwater trawls for collection of epi-pelagic and meso-pelagic specimens.
8. As weather and time permits, make nightlight stations for fish and squid samples and hook-and-line fish samples.

9. On the homeward leg of the cruise, record the nature of deep scattering layers and individual acoustic targets and measure their volume reverberation and target strength levels.

PROCEDURES AND EFFORTS:

The Jordan covered about 11,400 nautical miles along a predetermined track. Weather permitting, about an 11 to 12 hour daily watch was maintained on the flying bridge from January 6 to February 29. Two sets of 20-power, 120-mm spotting scopes, one pair mounted to starboard and the other to port, were used to search the horizon and distant areas for bird flocks and marine mammal signs. The height of the glasses above the water was about 40 feet and under optimum conditions, visibility was possible to about 12 miles. The furthest marine mammal observation, however, was estimated to be about 9 miles.

From January 8 through February 12, two pairs of observers alternated watches on a hourly basis. From February 13 through February 29, watches were changed at two-hour intervals. Observers interspersed periods of searching with the 20-power glasses with eyeball and hand-held binocular scans of the near water. About 60 percent of the sightings were made with the 20-X glasses and the relative number of such sightings tended to increase as the cruise progressed. During a watch, observers switched glasses at approximately 15 to 30 minute intervals. During times of frequent sightings, 3 or 4 observers were present on the flying bridge and aided the effort. The observations were relatively evenly proportioned between the teams of observers and between port and starboard sides.

To identify and estimate numbers of porpoise, schools were approached as closely as practical, and when necessary, the ship deviated from its course for this purpose. During these approaches, purposeful searching for other porpoise schools or marine mammals was suspended. At the conclusion of the observation the ship returned to its predetermined course. No course changes were made to more closely observe marine mammals other than porpoise.

At times, environmental conditions rendered use of the 20-X glasses impractical, and the search was conducted by eyeball and hand-held binoculars. On other occasions, due to inclement weather, the flying bridge watch was secured and one or more observers maintained a casual watch from the ship's bridge.

The search effort is summarized below.

Potential daylight time available for search:	541 hours
Time lost due to weather:	56 hours
Time spent in approach:	48 hours
Time spent in other activities:	8 hours
Total search time:	429 hours
Total man-hours:	858 hours

The effectiveness of the search effort is greatly influenced by conditions of wind, sea, sun glitter, haze and clouds. In an attempt to equate these environmental conditions with the observational results, a daily effort and weather log was maintained. The search effort was considerably hampered by environmental conditions during the cruise. Search conditions for each day have been generalized into six categories ranging from "excellent" to "impossible". The classification for each day's search and the number of marine mammal observations made during that day are shown on the Jordan's cruise track in Figure I.

RESULTS:

Marine Mammals. Cetaceans. Eight species of dolphins were observed and identified. In addition, several dolphin sightings were unidentified to species. Four small-to-medium-sized whales species were noted, plus one category or grouping of unidentified beaked whales. One species of large whales was positively identified and two additional general groups were observed and enumerated. These species and groupings with their frequency of sighting and associations with birds and tunas are listed in Table 1. Specific information for each marine mammal sighting is listed in Tables 2 to 11; the distributions of the sightings are shown in Figures 2 to 11. Brief generalizations for each species and grouping follows.

These results should be considered as preliminary as the sighting logs have not yet been subjected to a full review.

Stenella attenuata (spotted dolphin) Table 2, Figure 2. Of the 17 schools sighted, 10 were located between 07°N and the equator and about 100°W. These schools represent a southerly extension of the known distribution of the offshore stocks. The most northerly noted school, southwest

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of the Revilla Gigedo Islands, observed on January 9, also represent a slight extension of the known distribution.

The four most westerly seen schools, bounded by about 128° to 122°W and 06° to 03°N, carried huge flocks of birds, and large yellowfin jumpers were seen with two of these schools.

The two small groups of spotted dolphins noted entering and leaving Puntarenas rode the vessel's bow wave and were probably from resident coastal stocks. The two other schools observed in the general area of Cocos Island and the Costa Rican mainland also exhibited bow-riding tendencies.

Coloration differences were noted in the two schools observed on February 22 just north of the equator at about 107°30'W. In these schools the degree of spotting was medium to sparse in adult-sized animals and the marginal line of their cape pattern was very distinct. This coloration is considered to be more characteristic of spotted dolphins previously observed considerably further west.

Four of the 17 schools of spotted dolphins were noted in association with lesser numbers of other dolphin species.

Stenella longirostris (spinner dolphin) Table 3, Figure 3. Seven schools of this species were observed. Three of these schools were identified as the eastern type stock. The school seen mixed with S. attenuata at about 17°N, 118°30'W represents an extension of the historical distribution.

Four of the seven schools were classified as whitebelly spinners. All of these observations were slightly outside the historically understood boundaries. However, the three observations made at about 05°-06°S appear, from color pattern differences, to be a separate stock from those normally encountered in the far offshore waters from approximately 800 km offshore to 140°W longitude.

Stenella coeruleoalba (striped dolphin) Table 4, Figure 4. During the course of this cruise, the 33 striped dolphin schools observed tended to be small, numbering about 100 animals or less in 25 of the 33 observations; the largest school noted consisted of only about 500 animals. These

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small groupings appear to be traveling schools rather than feeding or resting aggregations. While running, the "streaker" schools exhibited considerable degree of leaping and cavorting which creates conspicuous splashes and leaves a well-defined wake behind them reminiscent of Delphinus schools.

The five schools noted south of the equator represent an extension of the previously published distribution in the eastern tropical Pacific.

Only two schools were seen with a small number of birds, and only two schools were found in association with other dolphin species. No surface signs of tuna were noted with streaker schools.

Delphinus delphis (common dolphin) Table 5, Figure 5. Of the 37 Delphinus schools noted, 15 were comprised of about 100 or fewer animals. However, four schools were estimated to contain over 1000 animals. Two schools were mixed with lesser concentrations of striped dolphin and 12 schools were associated with birds. No surface indications of fish were noted in relation to Delphinus schools.

At least two major areas of concentration were noted: one in the local banks - Clarion Island region; the other in the Galapagos-equatorial region. In addition, one isolated sighting was made at 10°44'N and 130°30'W. At the latter location, the animal's coloration was subdued and the thoracic patch very dully colored or faint in contrast to those observed further north. The animals seen in the equatorial region were brightly colored but the thoracic patch was indistinct.

Lagenodelphis hosei (Fraser's dolphin) Table 6, Figure 6. Only one sighting of a school consisting of about 300-400 animals was noted near the southwestern extremity of the cruise track. This was a traveling school without associated birds. Immature animals were noted in the rear of the school.

Steno bredanensis (rough-toothed dolphin) Table 6, Figure 6. The one school of this species observed represented a small group of 30-40 animals. This school appeared to be traveling and was unassociated with birds and fishes.

Feresa attenuata (pygmy killer whale) Table 6, Figure 6.
One small school of 10 to 14 animals of this species was recorded.

Unidentified beaked whales. Table 6, Figure 6.
Five sightings of small whales that appeared to fit the coloration and external characteristics of the genus *Mesoplodon* were made. These sightings were clustered in a narrow region confined to about 089° to 085°W and extending across the equator from about 06°S to 09°N.

Tursiops truncatus (bottle-nose dolphin) Table 7, Figure 7.
Seven of the 12 schools of *Tursiops* seen where closely associated with islands and near-shore regions, and the two largest schools observed were seen in these situations. The other sightings were of small groups of less than 20 animals.

No associations were noted between *Tursiops* and birds or fishes, but on two occasions *Tursiops* were encountered in mixed schools with other cetaceans. Both of these sightings were adjacent to Puntarenas.

Grampus griseus (Risso's dolphin) Table 8, Figure 8.
All 16 schools sighted were of small size, and only three aggregations were comprised of more than 20 animals. School structure was typically very loose with animals milling about and scattered over a large area in small groups of 1 to 3 individuals.

No birds or fish signs were associated with any of the observations. On one occasion, *Grampus* were associated with *Tursiops*.

Grampus distribution was confined to the southwestern region of the cruise tracks, roughly centered at the Galapagos Islands and extending to about 09°W, 07°S, and 103°W.

Globicephala macrorhyncus (short-finned pilot whale) Table 9, Figure 9.
Twelve of the 14 pilot whale sightings were spread from the Galapagos Islands west to 132° in a relatively narrow band between 04°N and about 01°30'S. These sightings are generally correlated with the noted distribution of sperm whales (Figure 10). Two additional *Globicephala* sightings were made; one near Cocos Island and the other at about 05°S.

All pilot whale aggregations were small schools of 70 or less individuals. Ten sightings were of less than 20 animals.

Schools were never observed associated with birds or fish signs, and none were mixed with other species of marine mammals. All schools appeared to be traveling groups.

Orcinus orca (killer whale) Table 9, Figure 9.
All four sightings were adjacent to, or east of the Galapagos Islands.

The largest aggregation noted consisted of 20 to 30 animals.

Physeter catodon (sperm whale) Table 10, Figure 10.
Nine of the 12 sightings were made across a long track extending some 2000 miles eastward from about 125°W to near the Galapagos and narrowly restricted between about 03°N and about 01°30'S. As previously noted, sperm whale and pilot whale sightings appear to be correlated.

The largest aggregations observed were made up of about 25 individuals and five of the groups consisted of five or fewer animals. The ship did not deviate from its course to investigate sperm whale herds and no detailed information was obtained on age or sexual structure of the aggregations.

Balaenoptera acutorostrata (minke whale) Table 10, Figure 10.
Only three sightings of minke whales were made. Two of the sightings were on the equator and just east of the Galapagos. The other sighting was at about 15°N and 122°W. This individual closely followed the ship for over an hour.

Unidentified dolphins Table 11, Figure 11.
The nine sightings were spread along the cruise track with no obvious center of distribution or pattern. These sightings represented individuals or small numbers of animals, usually of a generalized dolphin-porpoise type. Very probably most were *Tursiops*.

Unidentified balaenopterids Table 11, Figure 11.
These four isolated sightings represent individuals, or, in one case, three animals that were identified as either fin or sei whales.

Unidentified large whales Table 11, Figure 11. Thirteen of the 19 observations were made along the extensive equatorial track in which sperm whale sightings were concentrated. These sightings represent either individuals or small groups of animals. Most of these sightings were essentially whale "blows" seen at considerable distances and frequently under adverse weather conditions.

Pinnipeds. Eight observations were made of pinnipeds. Five were of California sea lions (*Zalophus californianus*), and one was probably a northern elephant seal (*Mirounga angustirostris*). These sightings were made on 6 January in the vicinity of Guadalupe Island. Two additional observations were made of fur seals near the Galapagos Islands on 29 January. These were probably *Arctocephalus australis galapagoensis*. All of the observations were of individual animals.

Birds. Fourteen bird species, comprising about 6000 individuals were noted in association with 28 of the total of 92 porpoise schools of species of primary interest (*Stenella attenuata*, *S. longirostris*, *S. coeruleoalba*, *Delphinus delphis*. Thus about 30 percent of such schools were associated with birds and all 6 porpoise schools with surface signs of tuna were carrying large flocks of birds.

The vast majority of birds noted (94%) in association with porpoise were represented by eight species. These forms are listed in Table 12 in order of their observed frequency of association with porpoise schools.

Geographical differences of these primary bird associates with porpoise schools were noted. Off the Baja California penninsula, the kittywake gulls dominated; in the far offshore regions to the west, the sooty terns and shearwaters were of major importance; and in regions within 400-500 miles of islands and the mainland, the boobies and frigates predominated.

A total of about 60 bird species was identified and a total of about 26,000 to 27,000 individuals counted during the cruise. Twenty four bird specimens were collected. This material will be curated by the San Diego Museum of Natural History. A special report will be written dealing with the bird observations.

¿ANOGRAPHIC
ᴊATA:

A total of 224 expendable bathythermograph probes was dropped at about 50-mile intervals along the ship's course. All of the punched tapes were transmitted on a daily basis via teletype to Fleet Numerical Weather Central in Monterey. The XBT graphs have been turned over to Richard Evans, SWFC, for copying. Surface water samples were drawn at the approximate times of the XBT drops and analyzed for salinity. Because of a misunderstanding in technique, these analyses are of doubtful value. The thermosalinograph continuous recorder was run throughout the cruise. Due to stylus-ink problems, gaps are present throughout the record.

A total of 41 neuston hauls and 45 6-foot Isaccs-Kidd Midwater trawls was made. The samples will be analyzed by SWFC personnel.

NIGHT LIGHT STATIONS:

On eight occasions, a night-light was rigged and samples of fishes and squids were taken with dip-nets and squid jigs. Considerable difficulty in sampling squid was experienced.

FISH COLLECTIONS:

Three samples of large fishes were taken by hook and line. The specimens were identified and frozen for shipment to the DOMES Project, NWFC.

DEEP SCATTERING LAYER RECORDING:

During the Puntarenas-to-San Diego cruise leg, hourly volume scattering measurements were made during daylight hours at 11 and 30 Hz. The nature of scattering layers and large targets was also recorded. Generally, the complexity and scattering strength of layers tended to decrease from south to north. Few large targets were recorded beyond the influence of land and the Humbolt Current. These data will be analyzed by Isaac Davies of the Navy Undersea Center, San Diego, California.

RECOMMENDATIONS AND COMMENTS:

Four observers are adequate to man the glasses and make marine mammal observations. However, an additional person on each watch is necessary for detailed note taking and searching the near water. On future porpoise survey cruises a marine technician should be added to the scientific party to run XBT's, monitor and annotate recorders, and analyze salinities. With an additional person other parameters that might be correlated with porpoise distribution could be measured.

Identification of free ranging porpoises is subtle. In future cruises at least two of the four observers should have had previous field experience with marine mammals

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studies, preferably not related with the tuna purse seine fishery.

A "Marine Mammal Observation Log" should be written specifically for ship surveys. A standardized "Effort and Weather Log" should also be formulated. In the future, three pairs of glasses should be used. In addition to the two pairs mounted to port and starboard on the flying bridge, a third pair should be located on the boat deck near the bow. The latter pair would greatly aid in porpoise identification.

The glasses on the flying bridge should be provided with a shield and overhead cover to reduce wind buffeting and allow continued search during rainy periods. Photographic equipment needs to be augmented. While 35-mm SLR cameras are adequate, automatic 300-mm lenses should be available. A motion picture camera with a zoom lens should be provided to record dolphin behavior and field markings.

A relatively high percentage of the XBT probes malfunctioned, and replicate drops had to be made.

Communication between the Jordan and the Cromwell and radio station WWD was excellent, and greatly aided coordination between the ships and the SWFC.

Ms. Betsy Warder, Ship's Nurse, aided the scientific effort.

SCIENTIFIC PERSONNEL:

Eric Barham, Supervisory Fishery Biologist
Chief Scientist, NMFS

John Butler, Museum Technician, Smithsonian Institution

William Walker, Biological Technician, NMFS

Robert Pitman, Biological Aid, NMFS

Isaac Davies, Oceanographer, Navy Undersea Center
(second leg of cruise)

Date April 16, 1976

Prepared by: Eric G. Barham
Eric G. Barham, Supv. Fish. Biol.
Chief Scientist

Approved by: Izadore Barrett
Izadore Barrett
Acting Center Director

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Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 1. Marine mammals sighted, estimated numbers and associations with birds and tuna

DOLPHINS Primary species	No. of sightings	Estimated total no's observed Max Min	No. mixed schools	No. schools assoc. w/ birds	No. schools assoc. w/ fish signs
Stenella attenuata (Spotted)	17	11798 8520	2	8	4
Stenella longirostris (Spinner) Eastern	3	1700 1180	1	2	1
Whitebelly	4	730 560	1	4	1
Stenella coeruleoalba (Striped or streaker)	33	3869 2717	2	2	0
Delphinus delphis (common or whitebelly	37	19404 14906	2	12	0
OTHER SPECIES					
Lagenodelphis hosei (Fraser's)	1	400 300	-	-	-
Steno bredanensis (Rough-Toothed)	1	40 30	-	-	-
Tursiops truncatus (Bottlenose)	12	491 319	1	-	-
Grampus griseus (Risso's dolphin)	16	202 140	-	-	-
Unidentified dolphins	9	36 24	-	-	-
SMALL-MEDIUM WHALES					
Feresa attenuata (Pygmy Killer Whale)	1	14 10	-	-	-

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

	No. of sightings	Estimated total no's observed Max Min	No. mixed schools	No. schools assoc. w/ birds	No. schools assoc. w/ fish signs
Globicephala macrorhynchus (Short-finned pilot whale)	14	377 249	-	-	-
Orcinus orca (Killer)	4	43 33	-	-	-
Balaenoptera acutorostrata (Minke)	3	6 4	-	-	-
Unidentified beaked whales	5	6	-	-	-
LARGE WHALES					
Physeter catodon (Sperm)	12	132 88	-	-	-
Unidentified balaenopterids (Fin/Sei)	4	6	-	-	-
Unidentified whales	19	36 28	2	-	-
Total Sightings	195	39294-29120	11	28	6

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 2. Sightings of Stenella attenuata (Spotted dolphin)

Obs. No.	Date	Location	Estimated numbers*	Notes: Birds	Notes: Fish
20	9 Jan.	17°07'N; 118°30'W	160±40	mixed with none	E. Spinners none
25	16 Jan.	05°12'N; 128°40'W	2700±470	1650 birds mix w/ w.b. spinners	many yellowfin jumpers
26	16 Jan.	05°09'N; 128°46'W	1000±200	260 birds	YF jumpers
36	20 Jan.	02°58'N; 124°56'W	3000±500	29 birds	none
38	21 Jan.	03°50'N; 122°46'W	100±20	25 birds	none
49	25 Jan.	02°18'N; 107°24'W	12±2	none	none
53	26 Jan.	02°37'N; 104°15'W	30±5	raining	none
54	26 Jan.	02°45'N; 103°20'W	1200±200	raining	none
55	27 Jan.	01°36'N; 100°25'W	760±37 mix w/ striped d.	none	none
107	31 Jan.	00°29'S; 089°18'W	150±20	104 birds	none
109	31 Jan.	00°06'S; 089°04'W	80±20	1020 birds	none
120	3 Feb.	06°17'N; 086°39'W	350±50	1630 birds	yellowfin jumpers
127	4 Feb.	09°32'N; 084°53'W	15	none	none
128	10 Feb.	09°40'N; 084°47'W	2	near Puntarenas	

*Precision of the estimated number will vary depending on such factors as relative numbers, range of the sighting, length of observation time, behavior and size of the animals and environmental conditions. Thus, each sighting is an independent estimate and is given here and in the following tables as logged. The range of the total estimates is given below and summarized in Table 1.

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 2. (con't.)

Obs. No.	Date	Location	Estimated numbers	Notes Birds	Fish
131	10 Feb.	09°12'N; 084°49'W	450±50 mix w/ Tursiops	550 birds	Yellowfin jumpers
175	22 Feb.	00°52'N; 107°31'W	80±15	none	none
179	22 Feb.	01°28'N; 107°24'W	70±10	none	none
TOTAL: 17 schools			Max-Min 11798 8520	8	4

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 3. Sightings of *Stenella longirostris*

(eastern spinner)

Obs. No.	Date	Location	Estimated Numbers	Notes: Birds	Notes: Fish
20	9 Jan.	17°07'N; 118°30'W	40±10	mixed with spotted d. none	none
133	10 Feb.	09°02'N; 084°45'W	1000±200	many birds	YF jumpers
139	12 Feb.	02°40'W; 084°38'W	400±50	30 birds	none
TOTAL:	3 schools		Max-Min 1700 1180	2	1

(whitebelly spinner)

Obs. No.	Date	Location	Estimated numbers	Notes: Birds	Notes: Fish
25	16 Jan.	05°12'N; 128°40'W	300±30 mix w/ spotted d.	large flock 1650	Numerous YF jumpers
163	15 Feb.	05°48'S; 089°06'W	150±25	2 birds	none
168	16 Feb.	06°04'S; 092°45'W	175±25	9 birds	none
169	16 Feb.	06°21'S; 094°19'W	20±	5 birds	none
TOTAL:	4 schools		Max-Min 730 560	4	1

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 4. Sightings of *Stenella coeruleoalba* (striped dolphin)

Obs. No.	Date	Location	Estimated numbers	Notes: Birds	Notes: Fish
55	27 Jan.	01°36'N; 100°25'W	mix w/ spotted d. 40±3	none	none
56	27 Jan.	01°35'N; 100°19'W	100±20	none	none
58	27 Jan.	01°27'N; 099°56'W	200±50	none	none
59	27 Jan.	01°24'N; 099°49'W	100±20	none	none
61	27 Jan.	01°23'N; 099°41'W	80±20	none	none
62	27 Jan.	01°21'N; 099°35'W	100±25	none	none
63	27 Jan.	01°20'N; 099°32'W	100±25	none	none
67	27 Jan.	01°13'N; 099°12'W	50±10	none	none
71	28 Jan.	00°27'N; 097°02'W	50±10	none	none
72	28 Jan.	00°25'N; 097°00'W	70±5	none	none
73	28 Jan.	00°22'N; 096°57'W	55±5	none	none
79	28 Jan.	00°07'N; 096°45'W	150±25	none	none
96	29 Jan.	00°06'N; 092°36'W	mix w/ *Delphinus* 175±14	none	none
99	29 Jan.	00°11'N; 091°52'W	200±50	none	none
108	31 Jan.	00°24'S; 089°15'W	100±20	none	none
113	1 Feb.	03°30'N; 086°17'W	20±5	none	none
114	1 Feb.	03°36'N; 086°12'W	35±8	none	none
115	1 Feb.	03°36'N; 086°09'W	15±5	none	none
123	3 Feb.	06°44'N; C86°31'W	25±7	11 birds	none
135	11 Feb.	06°29'N; 084°10'W	30±5	none	none
137	11 Feb.	05°35'N; 084°16'W	45±15	35 birds	none
140	12 Feb.	02°40'N; 084°38'W	70±20	none	none

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 4. (con't.)

Obs. No.	Date	Location	Estimated numbers	Notes Birds	Notes Fish
141	12 Feb.	02°27'N; 084°30'W	150±25	none	none
143	12 Feb.	02°05'N; 084°49'W	6	none	none
147	12 Feb.	01°41'N; 084°47'W	40±10	none	none
150	12 Feb.	01°35'N; 084°46'W	50±10	none	none
				mix w/ *Delphinus*	
153	13 Feb.	01°07'S; 084°57'W	100±12	none	none
154	13 Feb.	01°40'S; 085°03'W	150±25	none	none
162	15 Feb.	05°45'S; 088°39'W	80±20	none	none
164	15 Feb.	05°48'S; 089°20'W	550±50	none	none
173	19 Feb.	01°07'S; 103°47'W	60±10	none	none
177	22 Feb.	01°00'N; 107°20'W	200±25	none	none
180	22 Feb.	01°53'N; 107°34'W	100±25	none	none
TOTAL:	33 schools		Max-Min 3869 2717	2	0

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 5. Sightings of *Delphinus delphis* (common dolphin)

Obs. No.	Date	Location	Estimated numbers	Notes: Birds	Notes: Fish
1	6 Jan.	30°24'N; 117°00'W	20±5	ran bow none	none
2	6 Jan	30°24'N; 117°00'W	15±5	10 kittywakes	none
3	6 Jan.	30°22;N; 117°00'W	15±5	numerous kittywakes	none
4	6 Jan.	30°19'N; 117°00'W	15±5	numerous kittywakes	none
6	6 Jan.	30°13'N; 117°00'W	10±2	50 kittywakes 1 jaeger	none
15	7 Jan.	24°44'N; 117°00'W	25±5	none	none
16	8 Jan.	20°46'N; 116°54'W	250±50	none	none
17	8 Jan.	20°38'N; 116°54'W	150±50	none	none
18	8 Jan.	20°03'N; 116°55'W	30±5	none	none
19	8 Jan.	20°03'N; 116°55'W	60±10	may be assoc. w/ #18 none	none
22-B	12 Jan.	10°44'N; 130°31'W	500±50	none	none
74	28 Jan.	00°14'N; 096°45'W	75±25	none	none
75	28 Jan.	00°10'N; 096°30'W	250±25	none	none
77	28 Jan.	00°19'N; 096°43'W	120±20	none	none
78	28 Jan.	00°08'N; 096°20'W	200±25	none	none
84	28 Jan.	00°02'N; 096°00'W	1000±200	none	none
86	29 Jan.	00°01'S; 093°26'W	900±100	none	none
87	29 Jan.	00°04'S; 093°15'W	25±5	none	none
89	29 Jan.	00°04'S; 093°14'W	400±50	2 masked booby	none
90	29 Jan.	00°02'S; 093°05'W	50±10	1 masked booby	none
92	29 Jan.	00°00 ; 092°56'W	3000±500	1 masked booby 1 sooty tern	none

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 5. (con't.)

Obs. No.	Date	Location	Estimated numbers	Notes Birds	Notes Fish
93	29 Jan.	00°06'N; 092°46'W	400±50	none	none
95	29 Jan.	00°06'N; 092°38'W	50±10	none	none
96	29 Jan.	00°06'N; 092°36'W	mix w/ striped d. 2325±175	none	none
98	29 Jan.	00°09'N; 092°12'W	350±50	none	none
101	29 Jan.	00°12'N; 091°50'W	500±100	90 birds	none
102	31 Jan.	00°49'S; 089°36'W	60±10	none	none
105	31 Jan.	00°34'S; 089°25'W	125±25	none	none
134	11 Feb.	07°00'N; 084°14'W	600±100	70 birds	none
151	13 Feb.	00°49'S; 084°47'W	175±25	none	none
152	13 Feb.	01°01'S; 084°55'W	450±50	none	none
153	13 Feb.	01°07'S; 084°57'W	mix w/ striped d. 400±50	none	none
156	14 Feb.	04°59'S; 085°00'W	2500±100	2 frigates	none
157	14 Feb.	04°04'S; 085°30'W	1200±200	none	none
183	26 Feb.	17°24'N; 114°06'W	100±50	20-30 birds	none
187	27 Feb.	18°59'N; 114°44'W	800±100	36 birds	none
190	1 Mar.	29°55'N; 116°36'W	10±2	none	none
TOTAL:	37 schools		Max-Min 19404 14906	12	0

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 6. Sightings of relatively rare species

Steno bredanensis (Rough-toothed dolphin)

Obs. No.	Date	Location	Estimated numbers	Notes Birds	Notes Fish
24	15 Jan.	07°02'N; 126°20'W	35±5	none	none

Lagenodelphis hosei (Fraser's dolphin)

Obs. No.	Date	Location	Estimated numbers	Notes Birds	Notes Fish
29	17 Jan.	02°28'N; 132°18'W	350±50	none	none

Feresa attenuata (Pygmy Killer Whale)

Obs. No.	Date	Location	Estimated numbers	Notes Birds	Notes Fish
37	20 Jan.	03°18'N; 124°21'W	12±2	none	none

Unidentified beaked whales

Obs. No.	Date	Location	Estimated numbers	Notes Birds	Notes Fish
116	1 Feb.	03°36'N; 088°09'W	3±1	none	none
132	10 Feb.	09°06'N; 084°48'W	1	none	none
145	12 Feb.	01°51'N; 084°48'W	2	none	none
155	14 Feb.	04°55'S; 084°59'W	1	none	none
165	15 Feb.	05°46'S; 089°28'W	2	none	none
			Max-Min 10 8		

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 7. Sightings of *Tursiops truncatus* (bottlenose dolphin)

Obs. No.	Date	Location	Estimated numbers	Notes No Birds No Fish
21	10 Jan.	15°36'N; 121°09'W	3	approached to 20 m of vessel
60	27 Jan.	01°23'N; 099°45'W	15±5	scattered over ½ mi. area
81	28 Jan.	00°04'N; 096°18'W	10±2	milling group
85	28 Jan.	00°01'N; 095°37'W	10±2	milling in tight group
110	31 Jan.	00°03'N; 088°56'W	1	close to vessel
112	1 Feb.	02°56'N; 086°41'W	10±2	moving slowly
117	3 Feb.	05°36'N; 087°06'W	20±2	bow riders leaving Cocos I.
130	10 Feb.	09°28'N; 084°48'W	225±50	mix w/ *Grampus* - organized in sm. groups - some bow riders
131	10 Feb.	09°12'N; 084°49'W	4±1	mix w/ spotted porpoise at outer edges of s. porp. school
184	27 Feb.	18°20'N; 114°44'W	8±2	bow riders approaching Clarion I.
186	27 Feb.	18°20'N; 114°43'W	2	bow riders leaving Clarion I.
189	29 Feb.	24°59'N; 115°45'W	100±20	swam around vessel drifting off Alijos Rocks
TOTAL:	12 schools		Max-Min 491-319	

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 8. Sightings of _Grampus griseus_ (Risso's dolphin)

Obs. No.	Date	Location	Estimated numbers	Notes No Birds No Fish
72	28 Jan.	00°25'N; 097°00'W	6±1	in area of sperm whales
78	28 Jan.	00°08'N; 096°20'W	8±2	simultaneous w/ _Delphinus_ obs.
94	29 Jan.	00°06'N; 092°40'W	10±2	
104	31 Jan.	00°33'S; 089°24'W	7±2	
119	3 Feb.	06°13'N; 086°41'W	30±5	
121	3 Feb.	06°31'N; 086°35'W	6	
125	3 Feb.	06°55'N; 086°25'W	5±1	one animal jumping
130	10 Feb.	08°28'N; 084°48'W	2	mix w/ _Tursiops_
136	11 Feb.	05°43'N; 084°16'W	1	
142	12 Feb.	02°18'N; 084°49'W	25±5	in area of logs, Ridley's turtles
157	14 Feb.	04°04'S 085°30'W	12±1	mix w/ _Delphinus_
159	14 Feb.	04°56'S; 086°04'W	5	
160	14 Feb.	05°05'S; 086°34'W	8±2	one animal actively leaping
166	15 Feb.	05°48'S; 089°40'W	30±5	milling in a loose aggregation
167	15 Feb.	05°55'S; 090°37'W	15±5	
172	19 Feb.	01°38'S; 103°38'W	1	
TOTAL:	16 schools		Max-Min 202 140	

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 9. Sightings of *Globicephala macrorhyncus* (short-finned pilot whale)

Obs. No.	Date	Location	Estimated numbers	Notes No Birds No Fish
27	17 Jan.	02°55'N; 131°48'W	60±10	linear, traveling school
39	21 Jan.	03°52'N; 122°18'W	40±5	milling about, few calfs
46	24 Jan.	03°53'N; 111°11'W	13±4	
48	25 Jan.	02°31'N; 107°42'W	20±5	random milling - probably some diving
51	25 Jan.	02°01'N; 106°37'W	8±2	milling group
64	27 Jan.	01°17'N; 099°25'W	2	moving slowly on surface
66	27 Jan.	01°13'N; 099°12'W	40±10	in vicinity of striped d. school
80	28 Jan.	00°06'N; 096°43'W	15±3	slowly traveling on surface
83	28 Jan.	00°01'N; 096°09'W	12±3	blowing, diving, one breaching
97	29 Jan.	00°09'N; 092°19'W	20±5	tight group resting on surface
124	3 Feb.	06°51'N; 086°31'W	20±5	closest approach 2 miles
161	14 Feb.	05°06'S; 086°37'W	50±10	long, linear school - one breaching
171	19 Feb.	01°34'S; 103°37'W	3	probably 1 male, 2 females
174	21 Feb.	01°05'S; 107°20'W	10±2	
TOTALS:	14 schools		Max-Min 377 249	

Orcinus orca (Killer whale)

Obs. No.	Date	Location	Estimated numbers	Notes No Birds No Fish
100	29 Jan.	00°11'N; 091°50'W	4	1 male and 3 females blowing and milling
103	31 Jan.	00°37'S; 089°29'W	7	moving slowly, one calf
146	12 Feb.	01°48'N; 084°48'W	25±5	spread over large area, 1 breached 4 times
158	14 Feb.	04°52'S; 085°36'W	2	
TOTAL:	4 schools		Max-Min 43 33	

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 10. Sightings of *Physeter catodon* (sperm whale)

Obs. No.	Date	Location	Estimated numbers	Notes No Birds No Fish
23	12 Jan.	10°36'N; 130°50'W	3±1	
35	20 Jan.	02°56'N; 124°54'W	3±1	largest whale separate from others
44	22 Jan.	01°54'N; 118°32'W	3±1	
45	22 Jan.	01°54'N; 118°00'W	25±1	spread over 2 miles
69	27 Jan.	01°08'N; 099°01'W	10	2 calfs, all in tight group
72	28 Jan.	00°25'N; 097°00'W	12±2	in long line
76	28 Jan.	00°20'N; 096°45'W	2±1	
170	19 Feb.	01°34'S; 103°37'W	5±2	
176	22 Feb.	00°55'N; 107°23'W	10±2	in vicinity of spotter school
178	22 Feb.	01°19'N; 107°21'W	25±5	also unident. baleen whale signals picked up on sonar
181	23 Feb.	05°00'N; 107°39'W	10±2	traveling herd
185	27 Feb.	18°20'N; 114°44'W	2	adjacent to Clarion I.
TOTAL:	12 schools		Max-Min 132 88	

Balaenoptera acutorostrata (minke whale)

Obs. No.	Date	Location	Estimated numbers	Notes No Birds No Fish
22A	10 Jan.	15°03'N; 122°14'W	1	stayed w/vessel about 1 hr.
71	28 Jan.	00°27'N; 097°02'W	3±1	in vicinity of *S. coeruleoalba* school
91	29 Jan.	00°01'N; 092°59'W	1	
TOTAL:	3 schools		Max-Min 6 4	

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Table 11. Sightings of unidentified dolphins and whales

Obs. No.	Date	Location	Estimated numbers	Notes No Birds No Fish
07	6 Jan.	30°11'N; 117°00'W	1	
11	6 Jan.	29°57'N; 117°00'W	3	in wake of vessel
14	7 Jan.	26°09'N; 117°00'W	1	
24	15 Jan.	07°02'N; 126°20'W	3±1	mixed with <u>steno</u> herd
33	18 Jan.	00°10'N; 131°19'W	4	
42	22 Jan.	02°18'N; 119°12'W	6±2	
111	31 Jan.	00°06'N; 088°50'W	8±2	
126	3 Feb.	07°03'N; 086°20'W	1	
129	10 Feb.	09°40'N; 084°49'W	3±1	
TOTAL:	9 schools		Max-Min 36 24	

Unidentified balaenopterids

Obs. No.	Date	Location	Estimated numbers	Notes No Birds No Fish
34	18 Jan.	00°08'N; 131°03'W	3	
40	21 Jan.	03°55'N; 121°55'W	1	in vicinity of <u>Grampus</u>
65	27 Jan.	01°15'N; 099°18'W	1	
122	3 Feb.	06°41'N; 086°30'W	1	
TOTAL:	4 schools		6	

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

Unidentified large whales

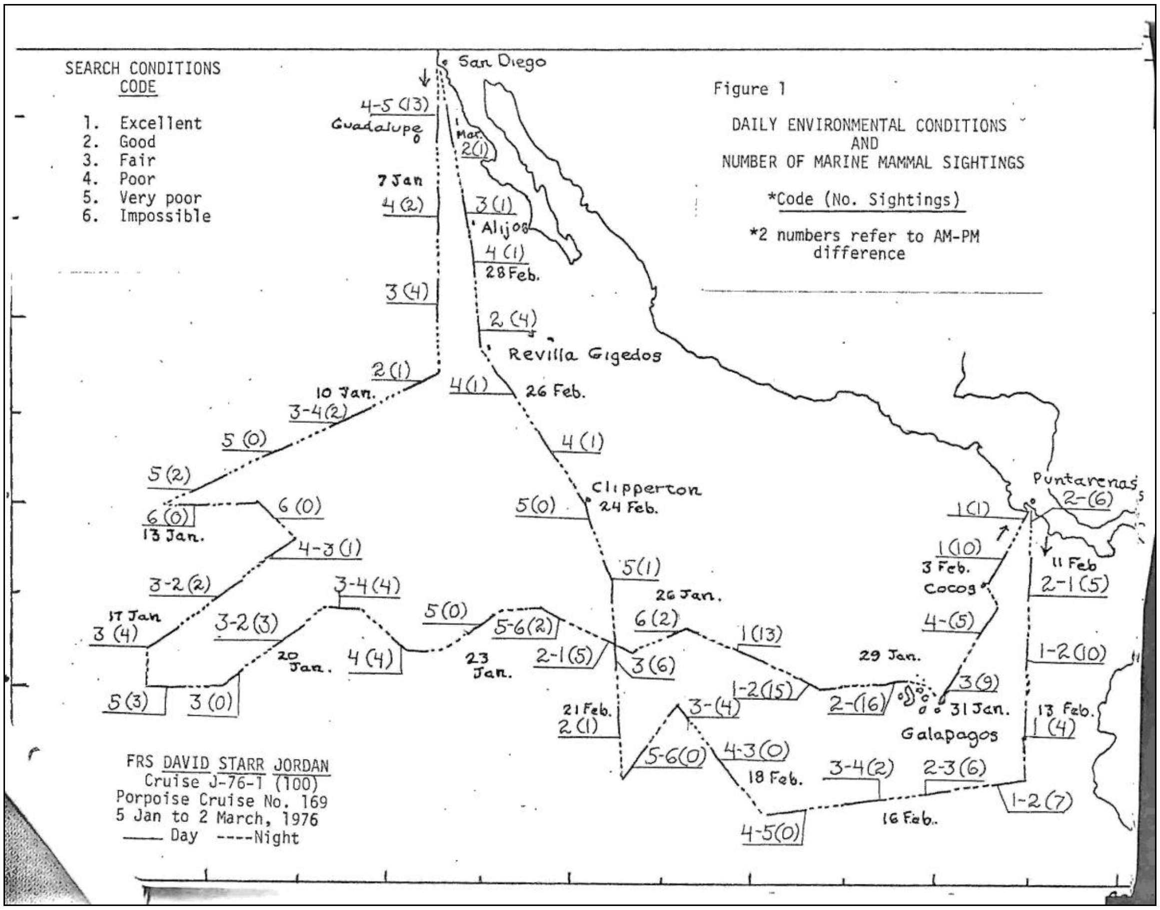
Obs. No.	Date	Location	Estimated Numbers	Notes No Birds No Fish
28	17 Jan.	02°47'N; 131°56'W	1	
31	17 Jan.	02°13'N; 132°38'W	3±1	
32	18 Jan.	00°00' ; 132°07'W	1	
41	21 Jan.	03°47'N; 121°40'W	1	
43	22 Jan.	01°58'N; 118°42'W	2	
46	24 Jan.	03°53'N; 111°11'W	2	in vicinity of pilot whales
47	24 Jan.	04°01'N; 111°00'W	1	
50	25 Jan.	02°15'N; 107°10'W	3±1	
52	25 Jan.	02°01'N; 106°37'W	1	
73	28 Jan.	00°22'N; 196°57'W	1	in vicinity of S. coeruleoalba
82	28 Jan.	00°02'N; 096°12'W	2	2 adults, 1 calf
88	29 Jan.	00°04'S; 093°15'W	3	
118	3 Feb.	05°58'N; 086°49'W	1	
138	11 Feb.	05°28'N; 084°19'W	1	
175	22 Feb.	00°52'N; 107°31'W	5±2	in vicinity of S. attenuata
178	22 Feb.	01°19'N; 107°21'W	1	in vicinity of Physeter
182	25 Feb.	13°32'N; 111°33'W	1	
183	26 Feb.	17°24'N; 114°06'W	1	in vicinity of Delphinus
188	28 Feb.	23°00'N; 115°15'W	1	
TOTAL:	19 sightings		Max-Min 36 28	

Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)

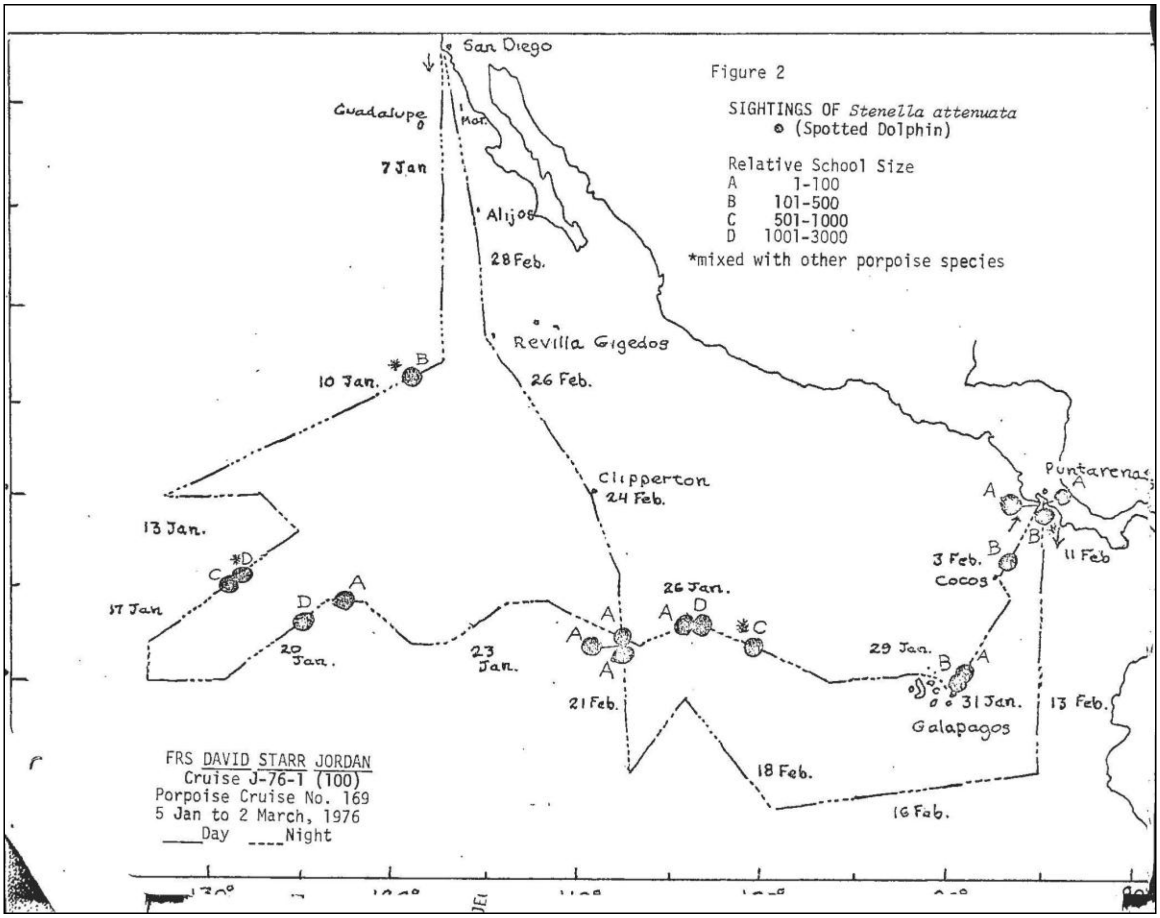
Table 12. Frequency of observation and approximate numbers of birds associated with porpoise schools of primary interest

Bird species	Times observed associated with porpoise	Estimated number of individuals associated with porpoise
Sula dactylatra (Masked booby)	11	445
Fregata minor		
Fregata magnificens (Frigate birds)	11	101
Sula sula (red-footed booby)	9	2461
Puffinus pacificus (Wedge-tail shearwater)	8	1466
Sterna lunata (Sooty tern)	8	558
Rissa tridactyla (Black-legged kittywake)	4	110
Pterodroma externa (Juan Fernandez petrel	2	240
TOTALS	53	5705

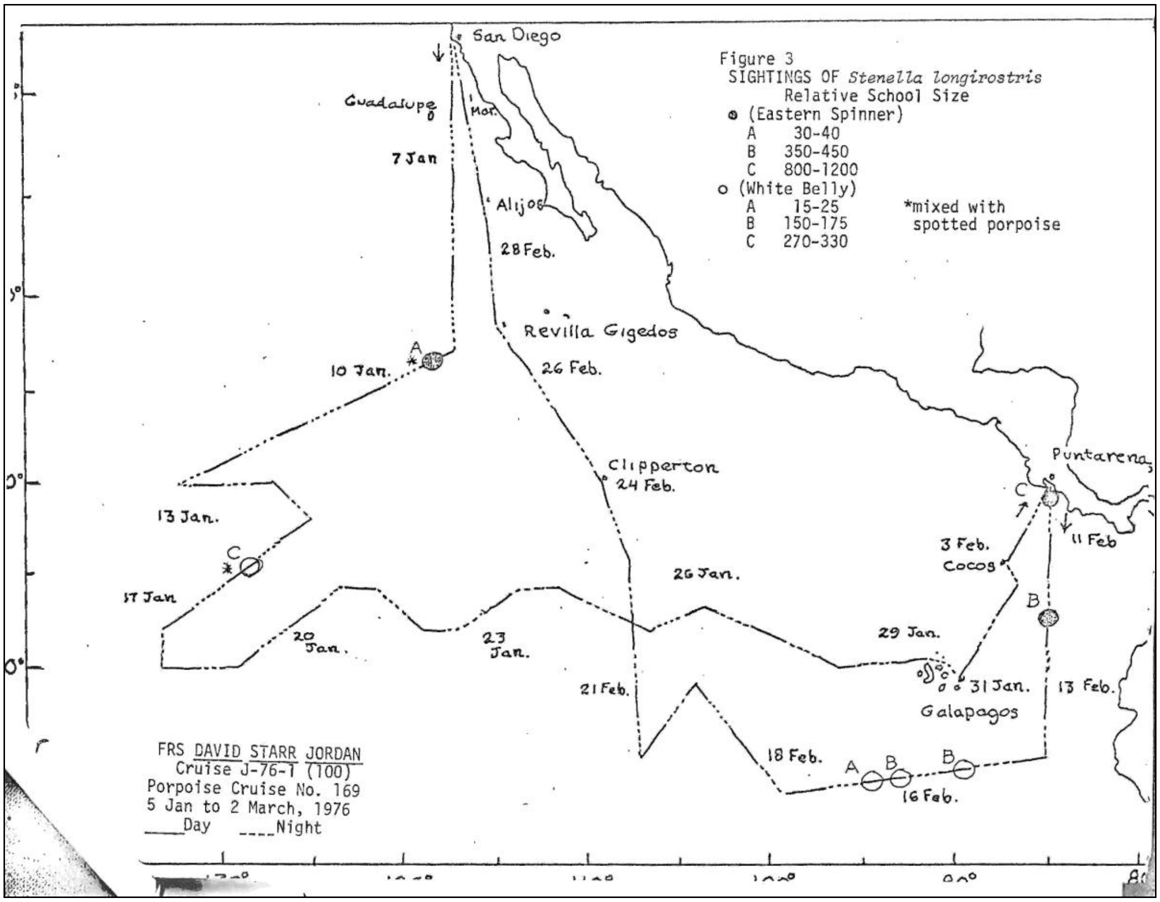
Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



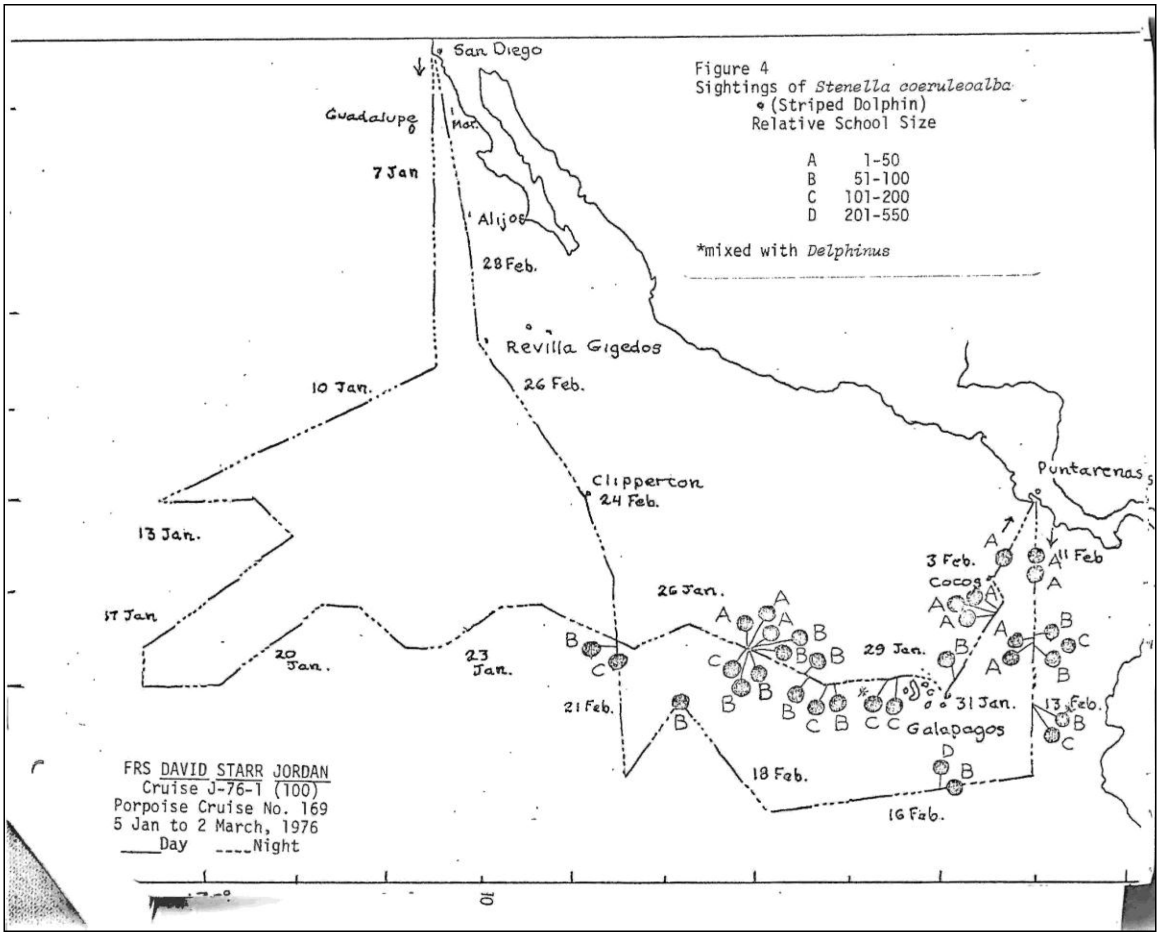
Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



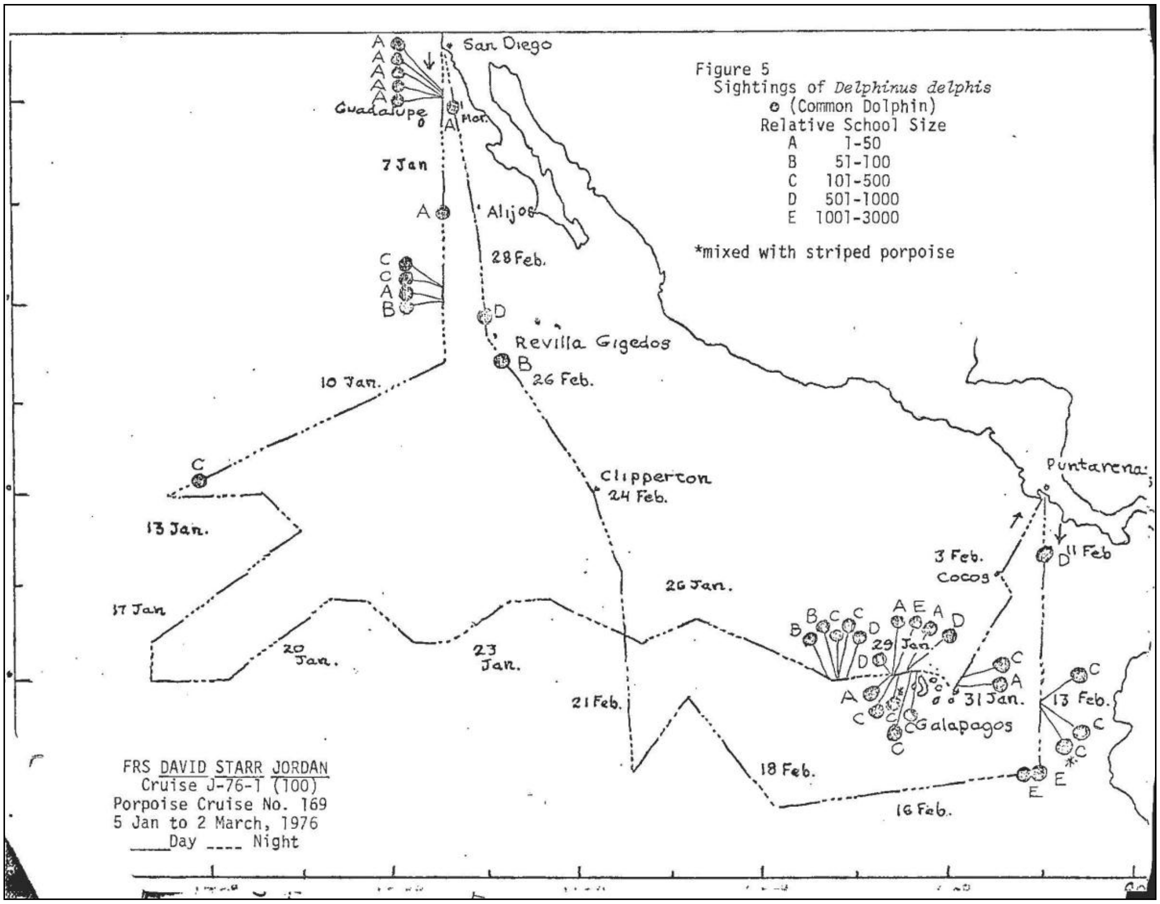
Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



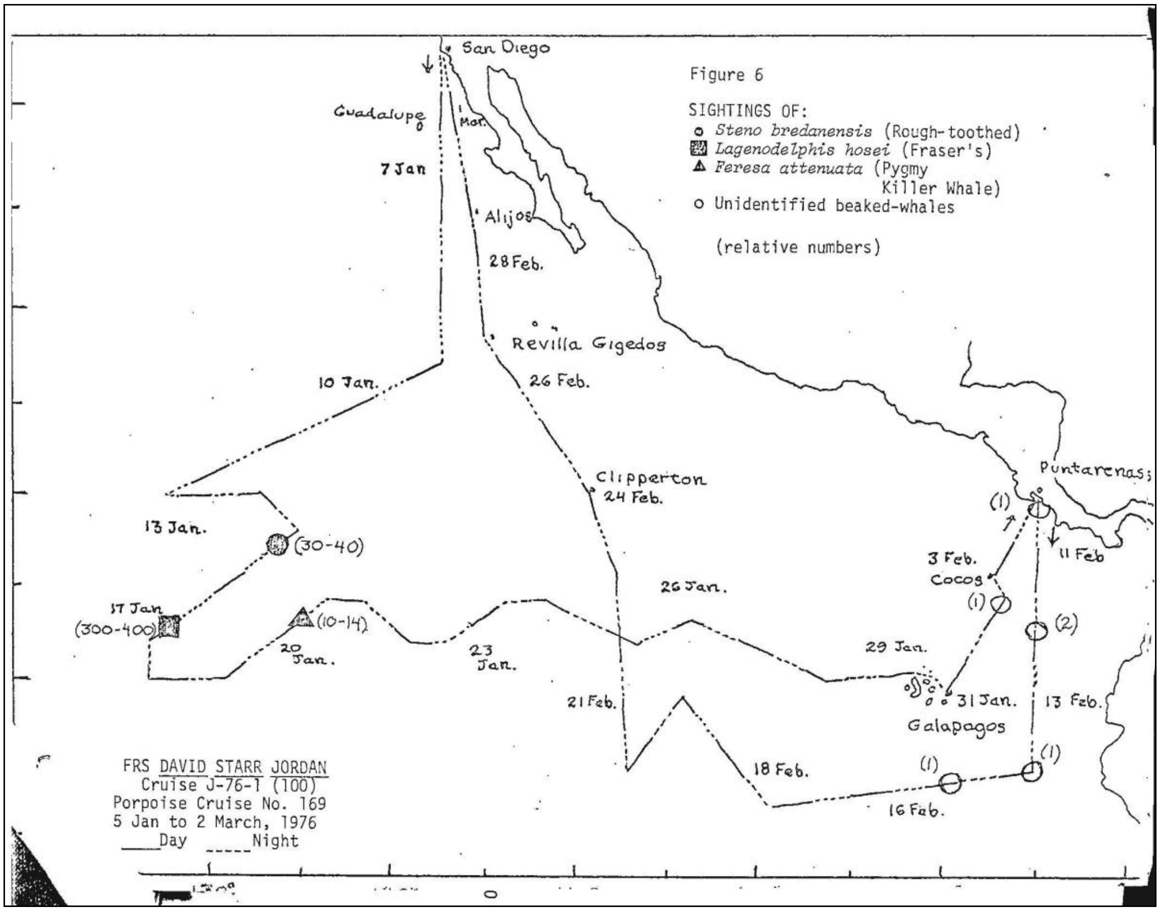
Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



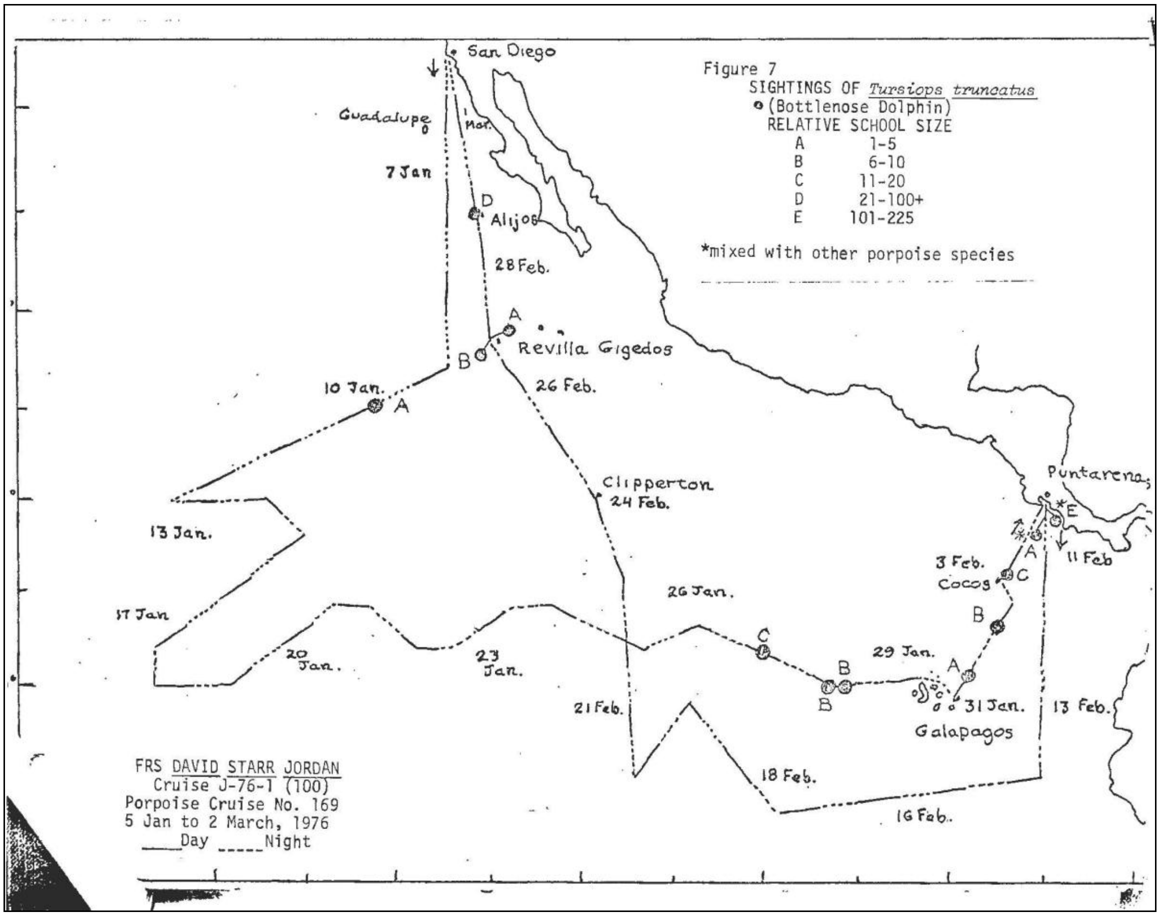
Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



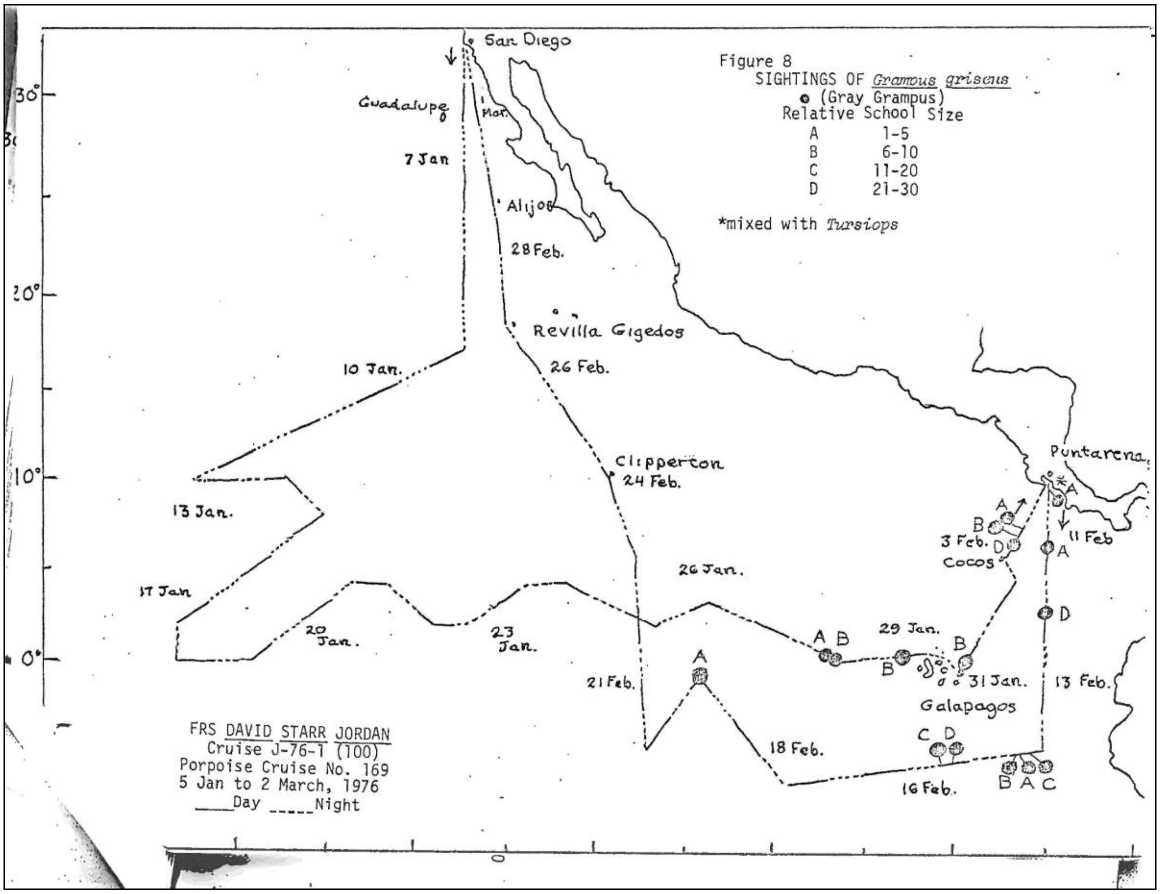
Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



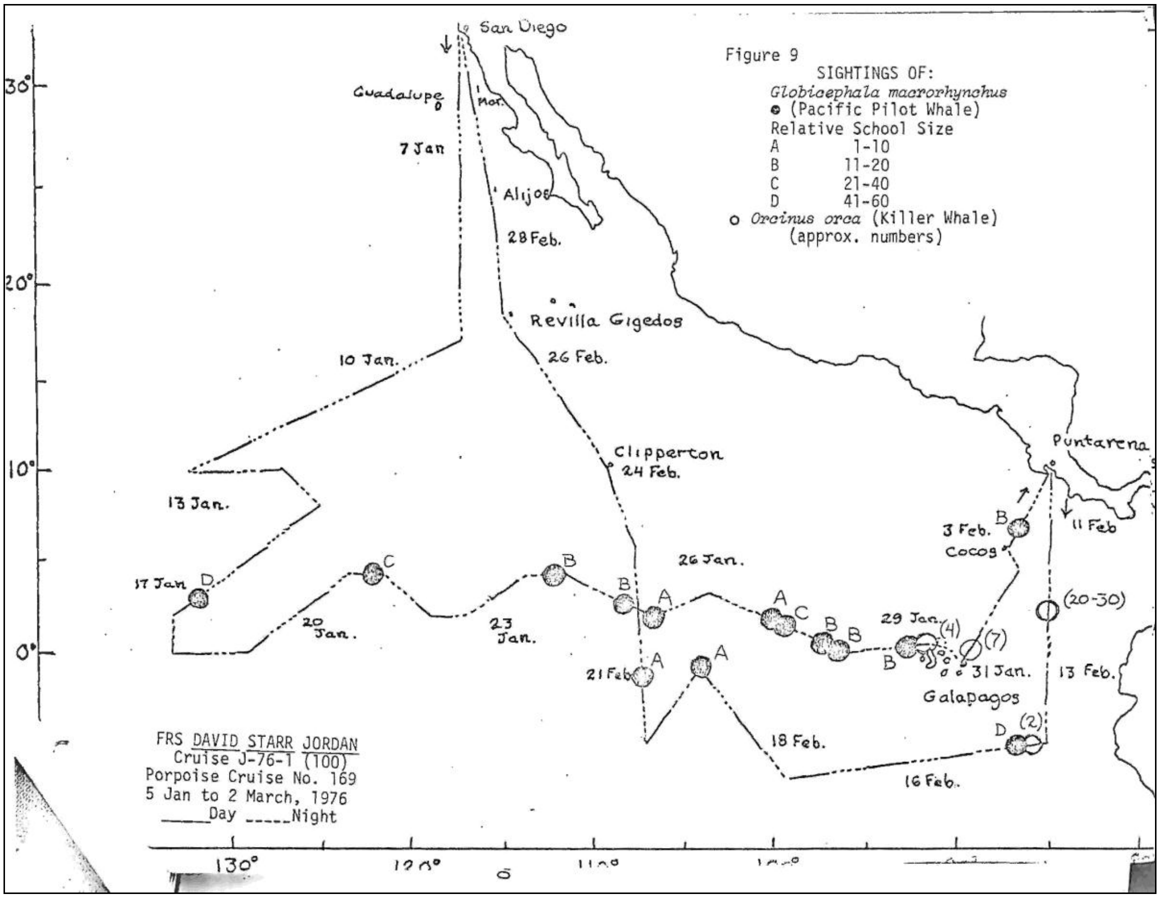
Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



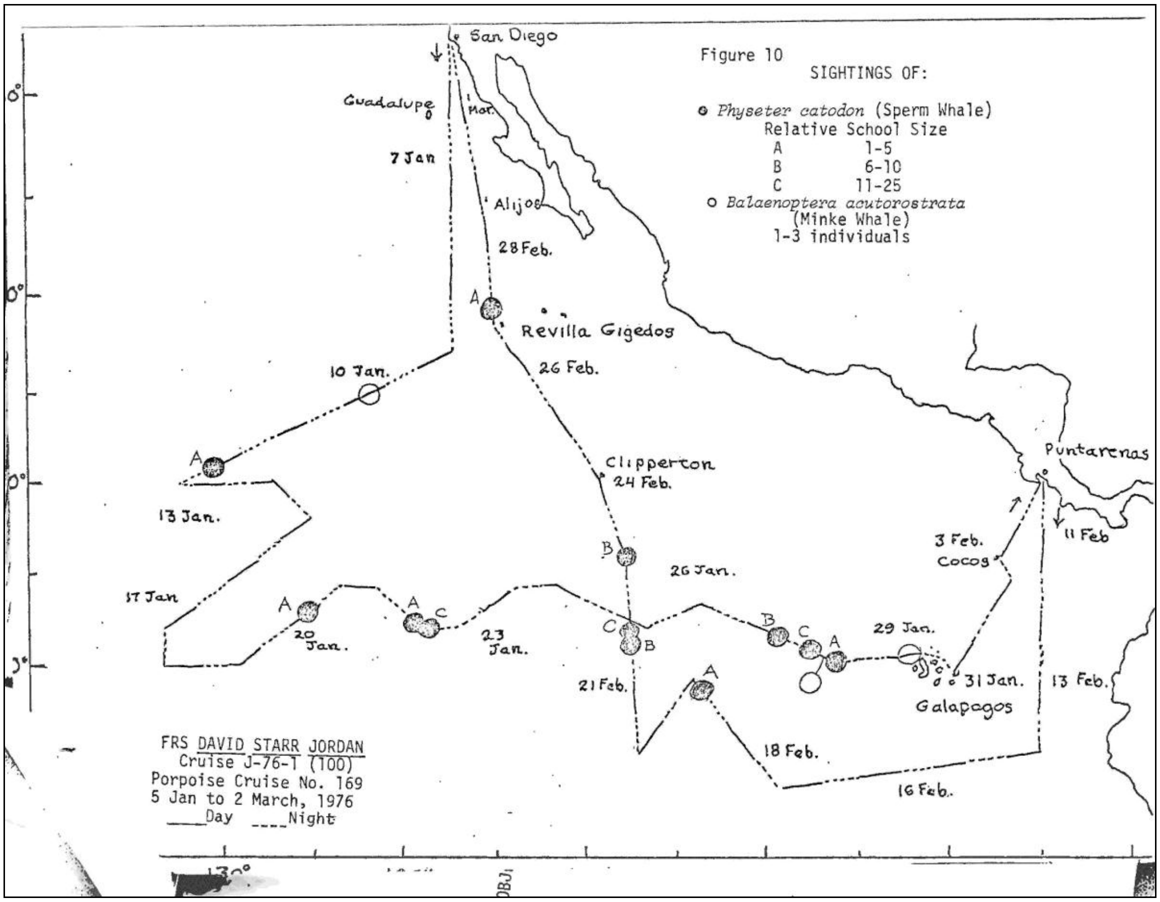
Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



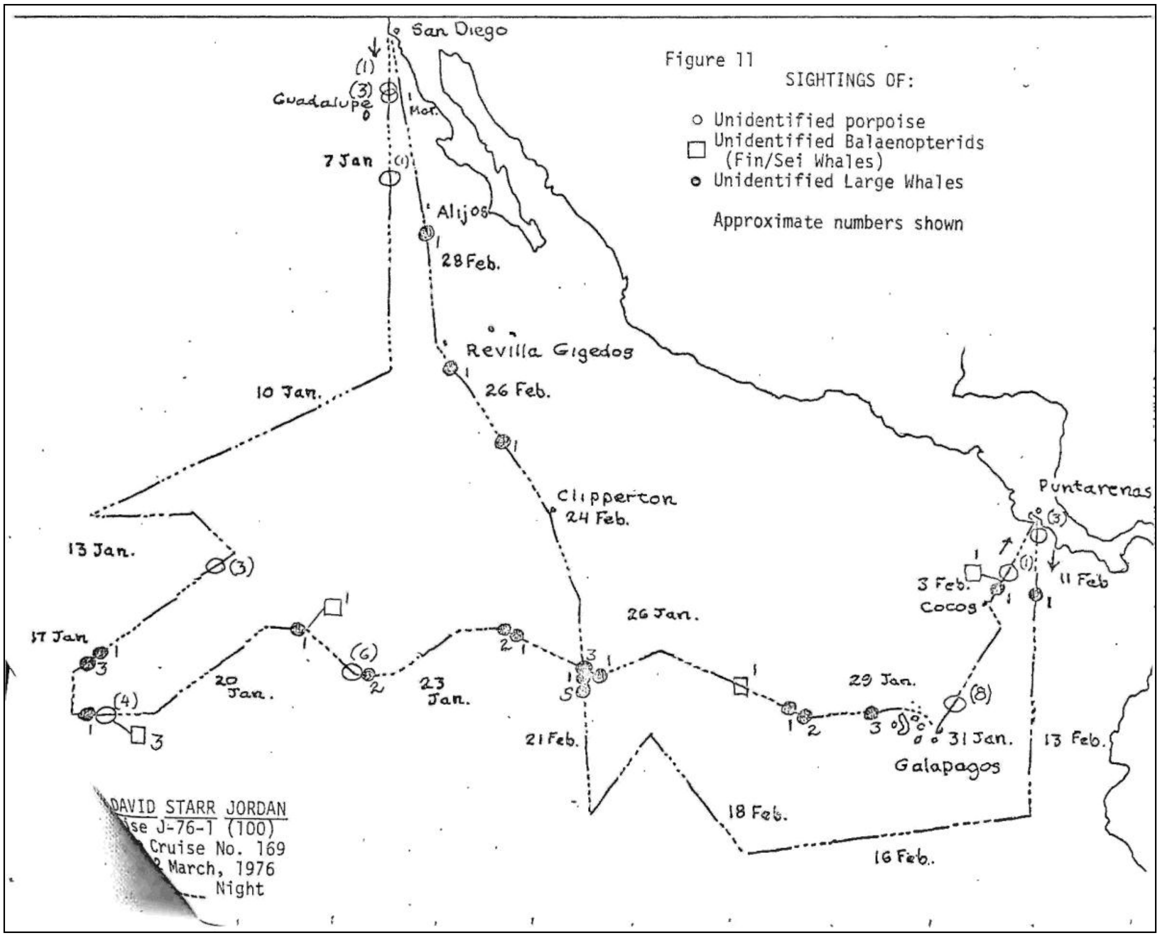
Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



Appendix 2C. Cruise report for SWFSC Cruise 0169. (Continued)



Appendix 2D. Cruise report for SWFSC Cruise 0207.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
SOUTHWEST FISHERIES CENTER
La Jolla, California 92038

CRUISE REPORT

VESSEL: R/V David Starr Jordan, Cruise J-76-96(105), Porpoise Cruise No. 207.

CRUISE PERIOD: October 5 to November 18, 1976

ITINERARY: Depart San Diego, October 5, 1976
Arrive Manzanillo, Mexico, November 5, 1976
Depart Manzanillo, Mexico, November 9, 1976
Arrive San Diego, November 18, 1976

The cruise track covered about 5300 nautical miles (figure 1). The Jordan joined the Elizabeth C.J., on October 16 and began tuna-porpoise behavioral studies in conjunction with that vessel. The Jordan left for Manzanillo, Mexico on November 2 to refuel and change scientific personnel. She again joined the "C. J." on November 11 to complete the second leg of the cruise.

PURPOSE: To identify and define basic parameters of tuna and porpoise behavior and elements of the bond between them. Three major research groups were involved and each will report its findings separately.

Documentation and analysis of tuna-porpoise behavior studies will be reported under a Marine Mammal Commission contract with the University of California at Santa Cruz, Dr. Kenneth Norris, principle investigator. Acoustic and bioacoustic studies will be reported by Dr. Frank Awbry, San Diego State University, principal investigator under a NSF-RANN contract. Objectives, responsibilities, and results of the R/V David Starr Jordan's contribution are reported here.

OBJECTIVES: 1. To track three radio-tagged schools of porpoise in order to study a variety of behavioral aspects over extended periods.

2. Identify and photograph all marine mammal sightings and estimate their numbers. Note associations with fish, turtles and birds.

3. Collect oceanographic and weather data on a regular basis, including surface temperatures, salinities, and XBT's.

4. Accommodate personnel unable to be housed on board the tuna seiner and serve as a repository for equipment and samples.

5. Collect sonar data on the abundance of food organisms available for tuna and porpoise and make oblique tows with an Isaacs-Kidd trawl in order to gain information on the composition of the food resources.

6. Act as a laboratory for dissections of fish and porpoise kill incidental to the commercial fishing operations.

7. Collect birds associated with tuna schools for stomach analysis.

METHODS AND PROCEDURES:

The Jordan operated in close proximity to the tuna-seiner, Elizabeth C.J. throughout the study period. Scientific personnel, living on board, transferred to and from the seiner at the start and end of each day. During each seine set the Jordan moved to within 300 meters of the seine and launched from one to four skiffs depending on the research activity planned for that set. Typically, the acoustics team used the ship's Boston Whaler to deploy their transmitting and receiving equipment while the underwater observation and filming teams used two small inflatable skiffs.

During two sets, porpoise were tagged with radio transmitters and color-coded streamer tags. The intent was to track them for 24 hours and reset on the same school to collect measurements of distance traveled, diving rhythms, turning rates, school cohesiveness and rate of acquisition of new fish. Multiple electronic equipment failures precluded satisfactory completion of this objective.

Collection of data on the abundance and kinds of organisms potentially available as food for tuna and porpoise was terminated early in the cruise because of the low porpoise kill rate.

Appendix 2D. Cruise report for SWFSC Cruise 0207. (Continued)

RESULTS:

1. Four porpoise were tagged with radio transmitters from each of two different schools. One individual from the first school was tracked by the *Jordan* for 13 hours when electronic difficulties forced its termination. Good data were collected during the 13 hours on diving frequency, traveling speed and distance, and school cohesiveness. The other three tagged porpoise were lost almost immediately. The animals tagged in the second school were also lost immediately due to additional electronic problems. The third attempt to radio tag was cancelled when replacement tracking equipment failed to operate properly when tested.

2. Twenty-four marine mammal sightings were recorded during 43 hours of observations. When time and conditions permitted, the *Jordan* would alter course to identify, photograph and record sounds of these animals.

3. A continuous thermo-salinograph record was monitored throughout the cruise. Forty XBT traces were recorded and weather reports were taken three or four times a day.

4. The *Jordan* provided comfortable accommodations for the scientific personnel and ample space for all gear and equipment.

5. Sonar data on the abundance of food organisms for tuna and porpoise were collected for five stations and one oblique, mid-water tow was made. Further stations were cancelled due to lack of porpoise specimens and our inability to track (via radio tags) schools of porpoise for extended periods.

6. Extremely low porpoise mortalities incidental to fishing and research operations negated the necessity to dissect animals aboard the *Jordan*.

7. Collection of birds was cancelled because of manpower and time requirements during fishing sets.

Appendix 2D. Cruise report for SWFSC Cruise 0207. (Continued)

SCIENTIFIC PERSONNEL: Chief Scientist David Holts, Fishery Methods and Equipment Specialist, NMFS.

Scientific Staff:

Leg 1, October 5 - November 6, 1976

Steve Leatherwood, Acoustician, Naval Undersea Center
Donald Ljungblad, Electronic Technician, Naval Undersea Center
William Rogers, Research Assistant, Univ. of Calif., Santa Cruz
Edward Mitchell, Biologist, Environment Canada
Phillip Vergne, Marine Scientist, Living Marine Resources
Joe Thompson, Sr., Cinematographer, Seavision Productions
Joe Thompson, Jr., Photo. Asst., Seavision Productions
Frank Awbry, Professor, San Diego State University

November 2-6, 1976

William Perrin, Biologist, NMFS
Kenneth Norris, Professor, UCSC

Leg II, November 7-18, 1976

Nancy Lo, Statistician, NMFS
Karen Pryor, Ethnologist, Porpoise Rescue Foundation
Rogers, W., Research Assistant, UC, Santa Cruz
Thompson, J. Sr.
Thompson, J. Jr.

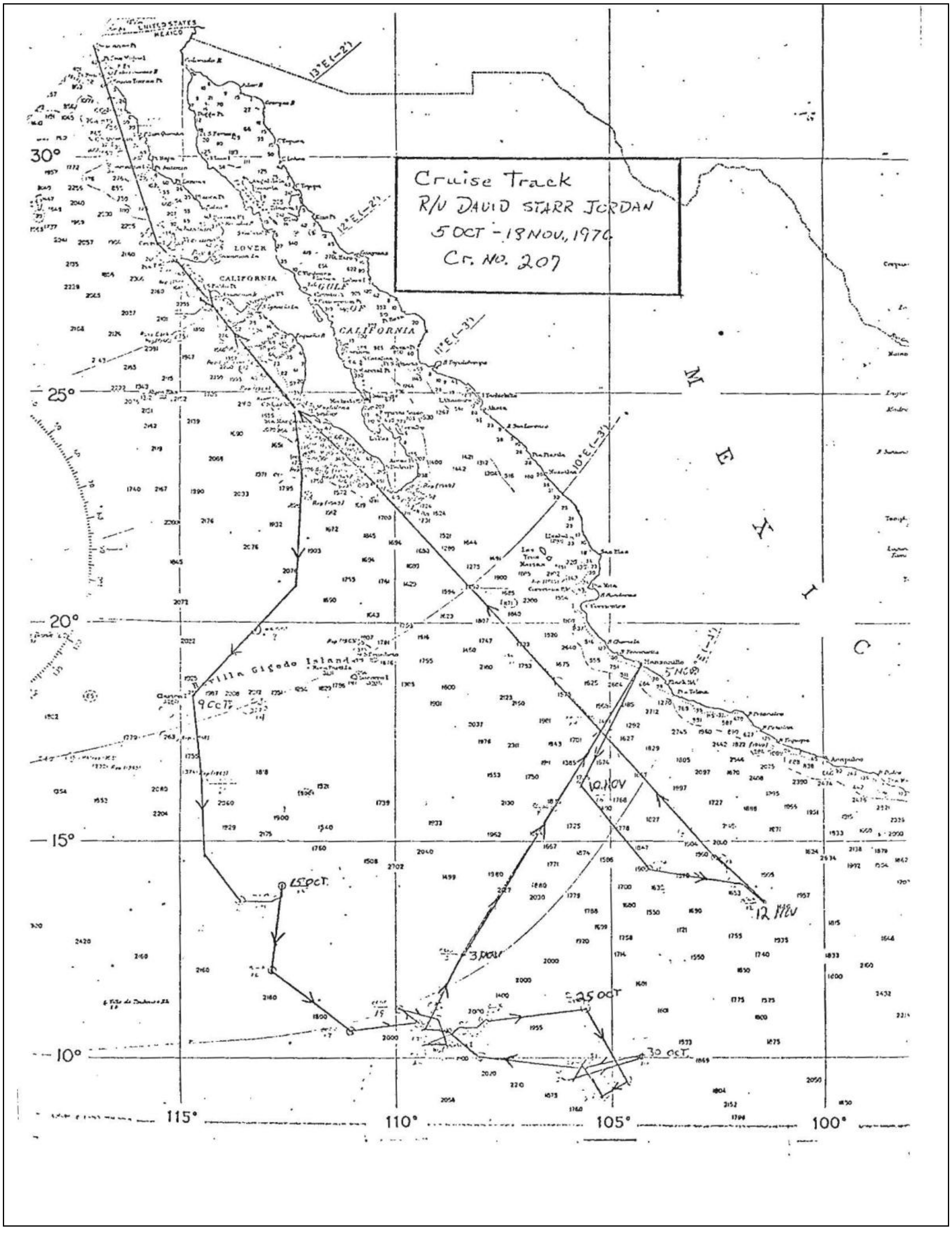
November 12-18, 1976

Warren Stuntz, Research Associate, Univ. of Calif. Santa Cruz

Date: 24 Jan. '77 Prepared by: David B. Holts
David B. Holts
Chief Scientist

Date: 1/26/77 Approved by: Izadore Barrett
I. Barrett
Acting Center Director

Appendix 2D. Cruise report for SWFSC Cruise 0207. (Continued)



Appendix 2E. Cruise report for SWFSC Cruise 0208.

Coe & Vergne 1976

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U.S. DEPARTMENT OF COMMERCE
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National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

CRUISE REPORT
(Gear Research)

VESSEL AND EQUIPMENT: Chartered tuna purse seiner M/V Elizabeth C.J. (Nicholas L. Lavalouis, Master; Manuel Jorge, Fish Captain; Joe Jorge, Alternate Fish Captain). NMFS Cruise No. 208, Contract No. 03-6-208-35483. The vessel is 252 feet long with a 42-foot beam and a draft of 21 feet. She can carry up to 1700 tons of frozen tuna in 10 pairs of brine wells. Propulsion is provided by a twin screw system with two 2800 horsepower main engines giving a top cruising speed of 18 knots and a 400 horsepower bowthruster aids in maneuverability. The net used during the cruise was 700 fathoms long by 13 standard 4-1/4" mesh strips deep. The experimental "super apron" and double-depth safety panel of 1-1/4" mesh webbing (Fig. 1) were installed in the backdown area of the net.

CRUISE PERIOD: October 7, 1976 to December 9, 1976.

AREA OF OPERATION: Yellowfin tuna fishing grounds off Mexico and Central America within the Inter-American Tropical Tuna Commission's regulatory area (CYRA).

PURPOSE OF CHARTER: To test a modification of the "Bold Contender" system, termed the "super apron" and to develop techniques for its efficient use in reducing incidental porpoise mortality during commercial tuna purse-seining operations. This work to be performed in partial conjunction with tuna-porpoise behavioral studies during a portion of the same cruise period.

OBJECTIVES:

1. To evaluate the effectiveness of the "super apron" modification of the "Bold Contender" system in reducing incidental porpoise mortality.

2. To adjust flotation and deployment techniques during backdown to reduce the incidence of a prematurely submerged corkline and the resultant accidental loss of fish.

3. To adjust flotation and apron structure to permit controlled sinking of the backdown apex.

4. To conduct further tests of the use of a small, one-man inflatable raft to assist in porpoise removal during and after backdown.

RESULTS:

During the cruise 30,233 porpoise were captured and 915.5 tons of yellowfin tuna were taken in 45 net sets on yellowfin tuna associated with porpoise. One set was a water set and two sets were made on tuna associated with floating objects (logs) in which 90 tons of yellowfin and 5 tons of skipjack tuna were landed. Table 1 presents a summary of the catch and kill data for the behavioral research and gear research sets. Table 2 presents the date, location, catch, kill and raft-use statistics by set with subtotals for the gear and behavioral sets.

Porpoise mortality occurred on only five of the 45 sets made on tuna-porpoise-associated schools. Sixteen porpoises were killed on these five sets, four during the course of regular fishing operations and 12 during the activities of the scientific party. Excluding mortality during scientific activity, the mortality rates were 0.09 per set, 0.004 per ton of yellowfin caught in association with porpoise and 0.013% of the porpoise captured.

Fourteen net sets were made for the purpose of studying porpoise behavior in detail. As many as three skiffs and six divers were inside the net prior to and during backdown. In three of these sets (numbers 4, 5, 12) the presence of the divers and tagging efforts during backdown hampered porpoise release and resulted in 12 of the 16 deaths. The remaining four deaths occurred during backdown in two gear experimental sets that had no operational malfunctions. The animals became folded into the side of the backdown channel at a depth that precluded hand rescue.

The extremely low porpoise mortality rate experienced during this cruise is the result of the fishing captain and crew members' care and efficiency in setting and hauling their net, using speedboats to adjust the corkline (18 sets) and in backing down until all live porpoise were released (42 of 45 sets). These efforts in conjunction with the "super apron" and double-depth safety panel of 1-1/4" stretch-mesh webbing have allowed this vessel to achieve a record low kill rate.

The "super apron"

The apron-type appendage to the backdown area of purse seine nets was first tried on an NMFS-chartered vessel in the fall of 1974 and subsequently led to the development and successful testing of the apron-chute complex known as the "Bold Contender" system, 1 year later. It includes a porpoise safety panel of 1-1/4" mesh webbing 12 fathoms deep and 180 fathoms long. A 10-vessel mass test of the "Bold Contender" system in 1976 resulted in mortality rates substantially below the 1976 fleet averages for vessels using conventional nets, i.e., 2" stretch mesh in the safety panel. However, the mass testing revealed two generally recognized problems with its use. First, the smaller mesh size of the safety panel and apron-chute complex caused considerably greater drag when being pulled through the water during backdown than did the normal 2" safety panel. This caused the corkline perimeter of the backdown channel to submerge in the early stages of backdown, thus increasing the danger of loss of fish and necessitating a slower-than-normal backdown. Secondly, several vessels reported that the inability to sink the corkline at the apex of the backdown channel in the later stages of the procedure caused greatly increased need for hand rescue and longer backdown times.

To alleviate these problems the two-stage taper employed in the "Bold Contender" system (five mesh, two bar on the apron and one mesh, two bar on the chute) was changed to all five mesh, two bar. This straight taper allowed more even distribution of the downward pull on the corkline as backdown proceeded. Although the corklines did tend to sink slightly in the early stages of backdown, and backdown still had to begin slowly, no fish were lost at this stage during the charter and it was generally agreed that there was no problem.

With the "super apron" modification, the topmost strip of 1-1/4" webbing (designated as the chute in the "Bold Contender" system) is approximately 200 meshes shallower at the backdown apex than its predecessor. The fish captain was able to sink the backdown apex to release the porpoise at will during all stages of the procedure. The re-surfacing of the corkline after sinking was probably slightly slower than for nets with the 2" porpoise safety panel. Two or three speedboats were deployed at the backdown channel apex on every set to help prevent accidental fish loss and to hand-release porpoise as needed. The chief scientist estimated that approximately 18 tons of tuna were accidentally backed out of the net during porpoise release in the 45 porpoise sets during the cruise. In general, the fish captain and the alternate fish captain were pleased with the porpoise-saving characteristics of the "super apron."

Observations from the inflatable raft during backdown on the charter of the M/V Bold Contender (fall 1975) showed that spotted porpoise sometimes become passive and pile up on the bottom of the backdown channel where they can be mistaken for dead. The removal of the extra webbing in the chute (discussed above) eliminated the two-step shelf formed with the "Bold Contender" system. Thus, as backdown proceeded with the "super apron," the channel became progressively shallower and ramp-like, raising the "passive" spotters up and flushing them out of the net. This reduced the necessity for hand rescue considerably. Of the 146 animals hand-released from the raft during backdown, the rescuer was quite certain that most of them would have been backed out anyway. No porpoise were killed in the six porpoise sets for which the raft was not used.

The use of the "super apron" atop the small-mesh, double-depth safety panel is not without operational faults, primarily because of the increased drag of the small mesh as it is moved through the water or as it is held against a current. In each of the porpoise sets which caught 50 tons of tuna or more the corkline tended to sink after backdown in the area just outboard of the third bow bunch. Though only a few tons of tuna were lost in porpoise sets, approximately 35 tons were lost in set 36 (schoolfish on a log) in this area. Underwater observation of the net in that area showed that as the net is hauled in after backdown the small mesh squeezes the entrapped water against the bunches which act as a dam. The blocked water forces the small mesh outboard of the third bow bunch to canopy out and when stretched to its limit the corkline begins to sink. The faster the net was rolled the more rapidly water had to be squeezed out and the deeper the corkline sank. It was found that this kind of sinking could be easily alleviated by release of the third and second bunches slightly earlier than normal. With large catches (>50 tons) it may be necessary to roll the net aboard a little more slowly.

On set 33, schoolfish with a log, a very strong surface current and an oblique subsurface current caused the entire area of small mesh from the second bow bunch to mid-net to sink and stay down until the purse rings were brought up out of the deep current. The surface current moved the log and almost all of the fish over the sunken corkline. It was not possible to judge the degree to which the small mesh was responsible for the sinking but it surely contributed to it. To avoid this problem in areas of strong currents, the captain must note the current direction and position all sets to avoid pursing the small mesh area of his net against the current.

As with the "Bold Contender" system there is a tendency for the center of the "super apron" to fold into or out of the net in some sets. On 15 sets a speedboat was used without incident to open or adjust the back-down apex prior to backdown. No maintenance was required on the small mesh during the cruise and only a few broken meshes and shark holes were seen by the underwater observer.

Inflatable Raft

During 39 of 45 porpoise sets a small inflatable raft was used as an observation-and-rescue platform by one of the scientists. A mask and snorkel was employed. The raft man signaled the captain when the backdown release area was clear of fish. In addition, he assisted in the removal of the last few porpoise in the late stages of backdown. Generally, backdown was continued until the raftman signaled that all porpoise including the "passive" spotters (see above) had been released. In checking to see if all live porpoise were out of the net it was discovered that the raft man could hear vocalizations of porpoise that were still in the net but could not be seen. This final listening check became common practice and several animals were saved as a result. The raft was also used during backdown to herd the porpoise toward the release area. This seemed to work well but only if the raft stayed

Appendix 2E. Cruise report for SWFSC Cruise 0208. (Continued)

more than about 10 meters from the nearest animals. When some groups of porpoise (10-100) would refuse to go over the corkline during backdown the raft man would wait until they were congregated near the sunken corkline and then paddle straight at them making as much commotion as possible. The initial avoidance response of the nearest animals often started them over the corkline and backdown would proceed to completion.

In four sets with expected large catches of fish the raft was used to attach up to four flotation balloons to the corkline along the sides of the backdown apex to lessen the chance of fish loss if all of the fish happened to move into the apex at one time. This was probably a good safeguard but it was never really tested with a large catch. After backdown the balloons were collected in the raft to facilitate net retrieval.

SUMMARY:

The record low mortality rate experienced on the charter cruise is the result of the concurrent evolution of improved fishing techniques and gear modifications developed by NMFS and the tuna industry and increased awareness of the captain and crew of the necessity to reduce incidental porpoise mortality. The following general list summarizes the activities which allowed the low mortality rate

1. Set positioning to minimize negative effects of wind and current.

2. Early recognition of potential net collapse areas and use of speedboat(s) to prevent collapse.

3. Use of speedboats to herd porpoise out of potential danger areas.

4. Use of speedboats to adjust backdown area corkline prior to backdown.

5. Consistent use of two or three speedboats at backdown apex to prevent fish loss and to rescue porpoise.

6. Consistent backing down until all live porpoise are out of the net (very important).

Appendix 2E. Cruise report for SWFSC Cruise 0208. (Continued)

7. Use of person in inflatable raft to:

a) signal when backdown apex is clear of fish,

b) herd and hold the porpoise in the backdown apex,

c) determine by using a mask and snorkel and by listening, when all live porpoise are out of the net.

d) hand-releasing animals.

8. Incorporation of small-mesh, double-depth safety panel.

9. Incorporation of "super-apron."

PERSONNEL: James M. Coe, Chief Scientist (gear research), SWFC
Philippe Vergne, Porpoise Rescue Foundation

Date: January 17, 1977 Prepared by: James M. Coe
James Coe
Chief Scientist

Date: Jan 17, 1977 Prepared by: Philippe T Vergne
Philippe Vergne
Porpoise Rescue Foundation

Date: 1/17/77 Approved by: Izadore Barrett
Izadore Barrett
Acting Center Director

Date: Jan 17, 1977 Approved by: Frank Alverson
Frank Alverson
Manager, Porpoise Rescue Foundation

Appendix 2E. Cruise report for SWFSC Cruise 0208. (Continued)

Table 2. Set Data

Set no.	Exp. set no.	Date	Latitude (N)	Longitude (W)	Average crew est. of porp. caught	% spin. in porp. caught	*Tons YF	Speed-boats used to tow	Elapsed back-down time (mins.)	# Raft rescued during back-down	# Porp. live in net after back-down	# Raft rescued after back-down	Spotter killed	Eastern spinner killed	White-belly spinner killed	Other killed	Total killed
1		10-14	18°32'	113°55'	533	-	45	0	20	3	0	0	0	0	0	0	0
2		10-14	18°27'	113°52'	325	-	35	1	8	2	0	0	0	0	0	0	0
3	1	10-16	11°19'	113°02'	water set	-	0										
4	2	10-17	10°33'	109°25'	1350	13	65	0	16	5	1	1	6	1	0	0	7
5	3	10-18	11°15'	109°25'	950	3	25	0	20	0	0	0	1	0	0	0	1
6		10-19	10°45'	109°00'	275	-	12	0	20	0	0	0	0	0	0	0	0
7	9	10-20	10°25'	108°38'	350	1	15	0	9	1	0	0	0	0	0	0	0
8		10-20	10°22'	108°49'	975	30	25	0	13	0	0	0	0	0	0	0	0
9		10-23	10°52'	107°42'	175	-	5	0	14	0	0	0	0	0	0	0	0
10	6	10-25	9°33'	104°46'	213	-	10	0	25	0	0	0	0	0	0	0	0
11	7	10-26	9°14'	105°16'	1066	10	70	0	19	8	0	0	0	0	0	0	0
12	8	10-27	9°21'	105°38'	183	-	18	2	9	3	0	0	4	0	0	0	4
13	4	10-27	9°46'	105°47'	1033	17	65	2	10	5	0	0	0	0	0	0	0
14	5	10-28	9°45'	105°03'	300	-	8	0	11	3	0	0	0	0	0	0	0
15	10	10-29	9°44'	104°37'	1000	12	55	0	11	2	0	0	0	0	0	0	0
16		10-30	9°41'	104°40'	125	-	15	0	11	3	0	0	0	0	0	0	0
17	11	10-31	9°37'	107°22'	90	-	4	2	10	4	1	1	0	0	0	0	0
18	12	10-31	9°46'	107°54'	625	45	6	2	8	3	0	0	0	0	0	0	0
19	13	11-1	10°36'	107°52'	816	1	8	1	8	0	0	0	0	0	0	0	0
20		11-1	10°43'	109°06'	1066	6	30	1	17	0	0	0	0	0	0	0	0
21	14	11-2	10°40'	109°27'	283	-	8	1	9	4	0	0	0	0	0	0	0
22		11-2	11°27'	109°50'	766	-	8	0	26	2	4	3	0	0	0	1	1
23		11-4	18°21'	113°23'	866	78	10	1	16	5	0	0	0	0	0	0	0
24		11-4	18°34'	113°54'	933	5	50	0	7	5	0	0	0	0	0	0	0
25		11-5	18°40'	113°30'	1033	13	20	1	15	7	0	0	0	0	0	0	0
26		11-5	18°23'	113°30'	683	15	5	1	20	0	0	0	0	0	0	0	0
27		11-9	13°53'	104°21'	683	-	10	0	11	6	0	0	0	0	0	0	0
28		11-11	13°58'	101°35'	833	-	12	0	15	10	0	0	0	0	0	0	0
29		11-11	14°14'	101°34'	683	0	9	1	13	5	0	0	0	0	0	0	0
30	15	11-12	13°43'	101°39'	333	0	4	0	15	3	0	0	0	0	0	0	0
31		11-12	13°34'	101°28'	55	0	0	0	6	1	0	0	0	0	0	0	0
32		11-13	12°20'	102°51'	700	0	4	0	12	5	0	0	0	0	0	0	0
33		11-15	9°15'	100°18'	Sch. F	-	0										
34		11-16	9°20'	98°20'	266	-	45	1	10	4	0	0	0	0	0	0	0
35		11-16	9°08'	98°03'	433	-	12	1	8	2	0	0	0	0	0	0	0
36		11-18	10°15'	98°09'	Sch. F	-	90										
37		11-19	10°01'	97°31'	86	-	25	1	8	1	0	0	0	0	0	0	0
38		11-19	9°36'	97°15'	316	-	14	0	10	3	0	0	0	0	0	0	0
39		11-20	9°18'	97°50'	106	-	10	0	6	2	0	0	0	0	0	0	0
40		11-21	9°27'	97°46'	1400	-	35	1	12	3	0	0	0	0	0	0	0
41		11-21	9°42'	97°44'	266	-	16	1	13	0	0	0	0	0	0	0	0
42		11-21	9°45'	97°54'	300	-	7	1	12	2	0	0	0	0	0	0	0
43		11-23	15°30'	101°27'	1233	65	12	0	16	15	0	0	1	2	0	0	3
44		11-26	19°38'	111°21'	800	-	15	0	17	5	0	0	0	0	0	0	0
45		11-27	18°21'	114°18'	233	5	10	0	24	7	0	0	0	0	0	0	0
46		12-2	10°52'	109°53'	2500	5	32	0	12	3	0	0	0	0	0	0	0
47		12-5	19°13'	111°49'	550	-	25	0	15	4	0	0	0	0	0	0	0
48		12-6	18°55'	112°50'	1666	95	1.5	0	15	0	0	0	0	0	0	0	0
TOTAL (behavior sets)					8592		361	10	180 (Avg. 12.66)	41	2	2	11	1	0	0	12
TOTAL (gear sets)					21,641		554.5	12	422 (Avg. 13.61)	105	4	3	1	2	0	1	1
TOTAL (all sets)					30,233		1005.5	22	602 (Avg. 13.38)	146	6	5	12	3	0	1	16

*Tonnages are estimates made at time of set, not actual unloading weights.

Appendix 2E. Cruise report for SWFSC Cruise 0208. (Continued)

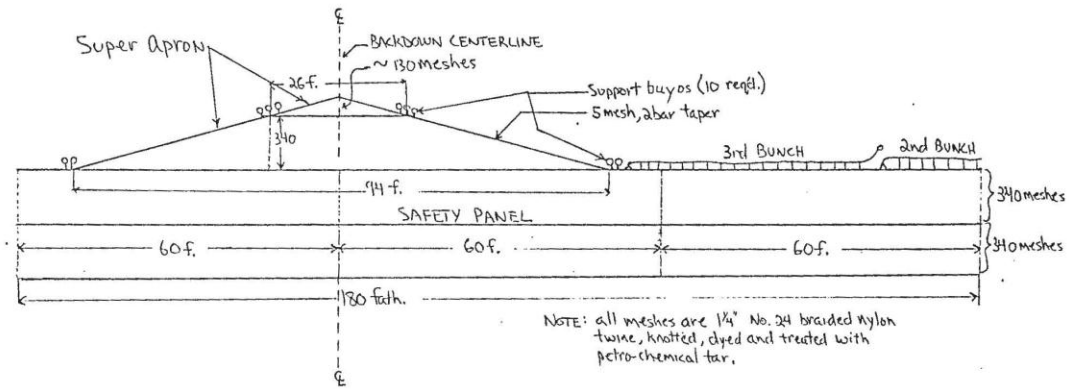


Figure 1. "Super Apron" Modification of the "Bold Contender" System, December 16, 1976 Assembly Diagram (vertical distances not to scale)

Appendix 2F. Cruise report for SWFSC Cruise 0212.

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

CRUISE REPORT Cr# 212

VESSEL: NOAA Ship Surveyor RP-5-76, Eastern Pacific Porpoise Distribution - School characteristics Study

CRUISE PERIOD: November 15 to December 9, 1976

ITINERARY: Depart Seattle, November 15, 1976
Arrive San Diego, December 9, 1976

OBJECTIVES:

1. To study the relationship of ship-based counts and counts from aerial photographs of porpoise schools.

2. To study the behavior of dolphin schools relative to the approaching ship and the effects of that behavior on school detecting and counting.

3. To study the distribution of dolphin schools relative to the oceanographic environment.

PROCEDURES: A shipboard mammal watch was maintained between 0700 and 1700 hours. The observers utilized two pairs of 20x binoculars mounted on the flying bridge. To identify and estimate numbers in porpoise schools, the ship deviated from its track and approached each school on the working grounds south of 15°N.

A helicopter search was begun on November 26, in the vicinity of Clipperton Island, continuing through December 4. In general there were two search periods during each of these days, the first beginning at about 0900 and the second at about 1330. Each search period was at least 2 hours long during which time the helicopter flew a rectangular track 2 miles ahead and 5 miles to each side of the ship.
Two scientific observers rode the helicopter along with the pilot and an additional technician. Porpoise schools were located either visually from the aircraft or by instructions from the ship based upon observations from the flying bridge or radar contacts. The distance and bearing of the porpoise school was measured by the ship's radar observation of the

helicopter over the school. Porpoise behavior and appearance were recorded by both still and movie photography. As the ship approached a school, the flying bridge observers made their standard observations on distance, bearing, and the biological characteristics of the school.

XBT profiles were taken at 3-hour intervals south of 31°30'N on the southward leg and south of 24°30'N on the return leg. Elsewhere XBT's were taken at 6-hour intervals.

Surveyor departed from its scheduled track on three occasions: to the repair docks in Seattle on November 15, toward Cabo San Lucas on November 23 to meet a Coast Guard helicopter that would lift off a sick crewman, and toward Acapulco on November 28-29 to repair the helicopter. A cruise track is attached to this report.

RESULTS: Forty-eight marine mammal sightings were logged. These included 19 whale sightings (13 unidentified, 6 others) and 29 porpoise sightings [8 unidentified, 7 spotted-spinner (Stenella attenuata - S. longirostris), 2 spotter (S. attenuata), 5 streaker (S. coeruleoalba), 4 northern right whale (Lissodelphis borealis), 1 Dall (Phocoenoides dalli), and 2 common (Delphinus delphis)]. The majority of tropical porpoise sightings were between 8° and 13°N and 105°-110°W, i.e., in the vicinity of Clipperton Island.

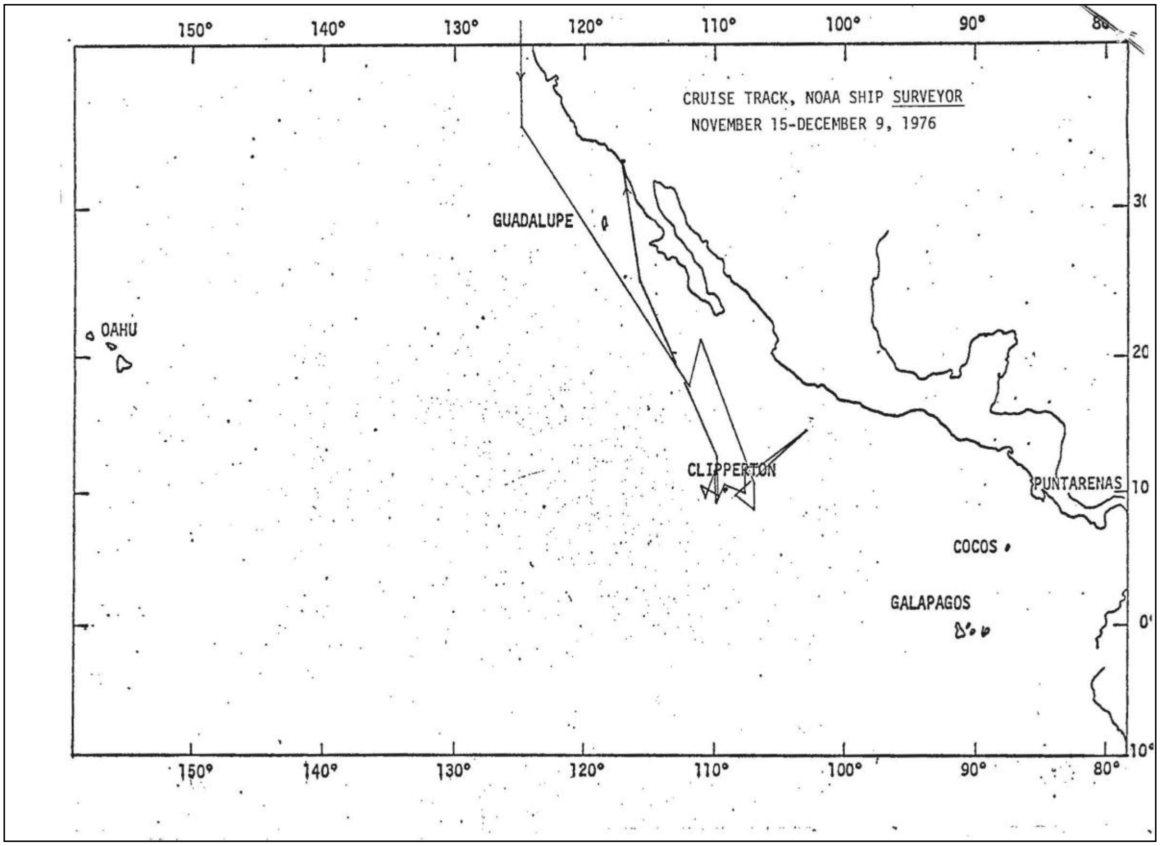
The helicopter was able to follow eight porpoise schools (common, spotted, spinner, streaker species). Photographic analysis of these schools will be reported later, after study. The schools did not appear to react to the helicopter flying between 1000- and 1500-feet altitude. Most schools swam quietly and the animals were difficult to spot by either ship or helicopter.

SCIENTIFIC PERSONNEL:
David Au, Chief Scientist, SWFC
Wayne Perryman, Assistant Scientist, SWFC
Frank Ralston, Biological Tech., SWFC
Dale Powers, Biological Tech., SWFC

Date January 26, 1977 Prepared by John T. Everett for
David W.K. Au
Chief Scientist

Date 1/27/77 Approved by Izadore Barrett
Izadore Barrett
Acting Center Director

Appendix 2F. Cruise report for SWFSC Cruise 0212. (Continued)



Appendix 2G. Cruise report for SWFSC Cruise 0213.

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Marine Fisheries Service
SOUTHWEST FISHERIES CENTER
La Jolla, California 92038

CRUISE REPORT

VESSEL: R/V *David Starr Jordan* Cruise DS-77-01-108, Porpoise Distribution Survey (Porpoise Cruise No. 213)

CRUISE PERIOD: January 4 - March 8, 1977

ITINERARY: Depart San Diego: January 4, 1977
Arrive Callao, Peru: February 4, 1977
Depart Callao, Peru: February 8, 1977
Arrive San Diego: March 8, 1977

OBJECTIVES: To study the distribution of offshore dolphin (porpoise) populations in the eastern tropical Pacific. The cruise track was designed to complement and extend the coverage by a concurrent aerial survey and a concurrent survey by the R/V *Townsend Cromwell*.

To study the variation and differentiation of species/stocks of dolphins, including color pattern and behavioral differences, throughout the ranges of the major stocks.

To study the characteristics of dolphin-seabird-fish associations in different oceanographic regions of the eastern tropical Pacific and the relationships to environmental variables.

To study the effects of environmental conditions upon sightability of marine mammals.

To obtain samples and measurements of oceanic squids for studies on their growth, productivity, and importance to dolphin, fish, and birds.

To study the distributions of epi- and mesopelagic fish, using Neuston and Isaac-Kidd trawls, and the relationship to dolphin distributions.

To study the distribution of phytoplankton concentrations, using the Turner fluorometer, and the relationship to oceanographic features and dolphin distributions.

To study the distribution of whale species other than the Delphinidae.

To study the distribution and feeding-searching behavior of sea birds and their relationships to marine mammals and pelagic fish.

To investigate procedures for increasing the efficiency of dolphin sighting and data gathering.

OPERATIONS: The *Jordan* cruised 12,000 miles along a predetermined track (Fig. 1). A 12-hour daily marine mammal watch was maintained, generally beginning at 0600 and ending at 1800 hours, LMT. An average of 105 miles was searched each day, totaling about 6,000 miles for the entire cruise. Vessel speed averaged 9.6 knots. The primary search tool was the 20 X 120 mm, USN MK 3, spotting binocular. A pair was mounted port and starboard on the flying bridge. The distance to the horizon was about 7 miles. The observers interspersed use of the 20-power binoculars with naked eye and with hand-held, 7-power binoculars. Observers stood 3-hour watches and interchanged searching from the port and starboard sides. Upon sighting a marine mammal school or herd, the ship usually approached the animals as closely as practicable for identification, photography, counts, and behavioral observations. At the conclusion of the observation the ship returned to its predetermined course.

XBT's were taken at 4-hour intervals each day (0600, 1000, 1400, 1800) and at 2400 during most of the track between San Diego and Callao. The thermosalinograph recorder was annotated with each XBT drop and a salinity sample was taken at 0600 and 1800 daily for calibration of the salinity record. XBT surface temperatures were continuously checked against the temperature trace and bucket thermometers.

A bird sighting log, flying fish count log, and an hourly watch log were maintained each day. The latter log was used to record weather and sightability conditions that affect searching.

Continuous measurements of surface layer chlorophyll were made using the Turner fluorometer. Calibration samples were taken twice each day.

A 6-foot (mouth width) Isaacs-Kidd midwater trawl (IKMT) and a 3-foot Manta net were used to sample the midwater and Neuston fauna, respectively at selected stations (Fig. 1). Each sampler was hauled for approximately 30 minutes. The IKMT samples, by oblique haul with 400 m wire out, were rough sorted aboard ship; the Neuston samples have been sent to Dr. A. Fleminger, SIO. At selected stations (Fig. 15) squids were taken by jig and dip net. These specimens were sexed and measured. Subsamples were frozen and preserved.

A running record of all biological and environmental variables encountered was kept throughout the cruise. This record was used to maintain a real-time understanding of the physical and biological environment being searched.

This survey was conducted concurrently with R/V *Townsend Cromwell* (Cruise TC-77-01-74), surveying waters farther to the west. An aerial survey was also concurrent.

RESULTS: 1. Marine Mammals

There were 260 separate sightings of dolphins and whales during this cruise. Whales accounted for 110 of the sightings. Delphinids, including killer and pilot whales, and the various species/geographical forms of dolphins, made up the remaining 150 sightings. The distributions of these sightings are shown in Figures 2-11, both for totals and separately for each species/stock. Larger taxonomic groupings are used in the case of some of the whales which are difficult to identify. School or herd size is also indicated in the figures.

A brief generalization of each species or species grouping follows. These results should be considered preliminary as the sighting records have not yet been fully reviewed.

Stenella attenuata (spotted dolphin), Figure 3

Twenty-one schools of this dolphin were seen, 11 of which were in mixed schools with whitebelly spinner (*Stenella longirostris*) or other, unidentified dolphins. School size ranged from 20 to 1500 animals, including associated species in mixed schools. These dolphins were sighted in Tropical, Equatorial, and southern Subtropical Surface Waters along the cruise track. There were no sightings west of 120°14'W near the equator; however, spotted dolphins were seen farther to the west near the equator by observers on *Cromwell*. It is apparent that the equatorial distribution was more extensive in 1977 than in 1976 when both vessels *Jordan* and *Cromwell* surveyed this area (*D.S. Jordan* Cruise No. DS-76-01-100, *T. Cromwell* Cruise No. TC-76-01-68). All sightings 3 or more degrees south of the equator were in Subtropic or transition waters. Birds were associated with four of the pure and five mixed schools. Sooty terns (*Sterna fuscata*) were the predominant species over the schools in the warm waters about the equator (5°N to 10°S). To the north, one mixed school was seen over the thermocline ridge at 10°N. *Pterodroma* petrels and wedge-tailed shearwaters (*Puffinus pacificus*) were associated with that school. *Stenella attenuata* is one of the more difficult dolphins to identify positively. Their overall dark appearance, their tendency to run low in the water with little jumping, and to form loose, scattered aggregations of 3 to 5 animals makes approach and identification difficult. Often they are seen at some distance jumping clear of the water, but they will shift to a more purposeful, low profile running behavior as the ship approaches. But sometimes these dolphins will continue jumping and "spy-hopping" throughout their escape run, especially when the ship is very near.

Stenella longirostris (spinner dolphin), Figure 4

The distribution of this species was similar to that of *S. attenuata* with which it is often associated. Twenty-one schools were seen, two being of the eastern type and 19 of the whitebelly or Hawaiian type. Both eastern spinner schools were seen to the north of the thermocline ridge situated near 10°N. In the remaining non-eastern type ("whitebelly" in Figure 4) schools, 15 were mixed schools (nine with *S. attenuata*, three with *S. coeruleoalba*, three with unidentified dolphins). Their school size ranged from 30 to 1500 animals total. There were four pure schools of greater-than-500 animals sighted south of the Galapagos Islands between 11° and 12°S. All four carried birds (sooty terns (*Sterna fuscata*), *Pterodroma* petrels, and frigates (*Fregata* sp.)). At least one of these schools was associated with tuna. No *S. attenuata* were seen in this southern area. Sooty terns were the usual bird species found with these dolphins in the tropical waters near the equator. *Pterodroma* petrels and wedge-tailed shearwaters were also associated with the schools sighted near 10°N. Twelve of the 21 sighted schools of *S. longirostris* were associated with birds. In all schools of the non-eastern type encountered, some individuals had a ventral keel and a black band separating the darker lateral field from the white, ventral surfaces. This band, the anteriorward extent of which varied, went completely around the anal region. These individuals appeared to be the larger ones in the schools. Spinner dolphins (whitebelly or Hawaiian) tend to run in a tight group, fanning out into a wide arc in front of the ship. Smaller subgroups often cross paths within the school and in front of the ship. A complete spectrum of jumping behavior was observed, ranging from "pitch-pole" or "spy-hop" exits to twisting jumps (with or without spinning) clear of the water, to high, arcing leaps. These aerial maneuvers often occurred while the school was running from the ship. High jumps and splashes were also seen among these dolphins at near-horizon distances.

Stenella coeruleoalba (striped dolphin or "streaker porpoise"), Figure 5

The distribution of this species appears similar to that of *S. attenuata* and *S. longirostris*. All of the sightings were along the equatorial belt and, as in the latter two *Stenella* species, this distribution was more extensive to the west than in 1976. Farther west this species was seen both along the equator and along the 10°N line by observers aboard *Cromwell*. There were 19 schools sighted from *Jordan*, three being mixed with whitebelly/Hawaiian-type spinners and one with an unidentified dolphin species. School size ranged from 15 to 600 animals. Only three of the schools were associated with birds (sooty terns or frigates). *S. coeruleoalba* are relatively large, powerfully-built dolphins. They were often first seen jumping high out of the water far toward the horizon. Some leaps were estimated to be at least 25 feet high. As the ship approached, these dolphins often interspersed low-profile swimming with hard running, accompanied by "spy-hopping", "chin slaps", somersaults, and twisting leaps. They frequently changed direction with groups of animals coming out of the water in long, powerful leaps as the school rearranged itself. This was especially seen when a group crossed the ship's bow. These dolphins are probably fast swimmers. It took *Jordan* 1 hour to catch up with one particular school. Later when back on course this school could still be seen 2 to 2.5 miles away, on an almost-parallel course. They were leaping and splashing, and executing repeated, flying bursts from the water.

Delphinus delphis (common dolphin), Figure 5

Two stocks of this species were seen. A northern stock in the California Current presented nine sightings with school size ranging from 1 to 450 animals. There were three sightings off Ecuador with school sizes ranging from 45 to 1200 animals. There were no birds associated with any of the *Delphinus* schools. No schools were sighted along the equator in contrast to the situation in 1976. The animals from off Ecuador had a more subdued coloration in comparison with the distinct and often vivid, "hourglass" pattern of the California Current stock. The southern animals presented an overall two-toned appearance with the "criss-cross" largely absent. *Delphinus* schools appear generally unafraid of the ship. Small groups from a school will often break away to bow ride. They may form a wide arc ahead of the ship, exhibiting much high jumping and splashing. Several schools seen appeared to be milling initially.

Grampus griseus (Risso's dolphin), Figure 6

Sixteen sightings of this species were made throughout the equatorial region and also in the California Current. Sightings were relatively more frequent near the coasts, especially to the southeast of the Galapagos Islands. School sizes were small, ranging from 1 to 75. A bird (*Fregata* sp.) was seen following one school. *Grampus* were often seen moving slowly, appearing unaffected by the presence of the ship. Some approached the ship or even bow rode. Two schools may have been associated with another dolphin, possibly *Tursiops* or *Steno*. Individuals in a school were sometimes widely scattered. Several schools were first sighted when individuals breached clear out of the water.

Steno bredanensis (rough-toothed dolphin), Figure 6

This species was sighted four times in waters near the equator. It appears to be a widely distributed, though relatively uncommon, species. The school sizes ranged from 8 to 25 animals, which may explain partly the few sightings. None were with birds. These dolphins are seen characteristically rafting or milling. They move aside rather than run from the ship, regrouping after the dodging maneuver, sometimes in shoulder-to-shoulder ranks. They move unhurriedly. While outmaneuvering the ship they may "spy-hop" or jump. One school was sighted at a distance of 1 mile, with individuals doing somersaults, flying high leaps, "pitch-poling", and "chin slaps."

Orcinus orca (killer whale), Figure 6

There were two sightings of killer whales, one on the equator, the other 7°S, southwest of the Galapagos Islands. School sizes were five and eight, respectively. No birds were with the whales. Both sightings occurred in the vicinity of the equatorial front where high salinity waters to the south meet low salinity waters of the tropics. The animals in one herd approached the ship, occasionally "spy-hopping." One large individual approached and departed from a rafting group of smaller individuals several times.

Feresa/Peponocephala (pygmy killer whale/melon-headed whale), Figure 7

There were at least one, probably two, sightings of one or the other of these species along the equator between 115 and 120° W. It is not clear which species was seen. Sightings of this species type were relatively more frequent from the *Cromwell*, working farther to the west. The first school of about 370 animals was sighted as splashes at 6 miles. The school was spread out in a broad band over 2 miles wide. At close range the animals bunched tightly together, forming a dense, wide arc or oval mass. They turned frequently as a school and charged through the water in a manner similar to that of *Lagenodelphis*. Photographs and field notes indicate that a small number of *Lagenodelphis* were mixed with this school. The *Feresa/Peponocephala* "porpoised" low, producing short, puffy blows and split the water with their rounded heads so that their bodies were almost continuously obscured by spray. Jumps clear of the water were infrequent. One animal that did jump clear, twisted to land on its side and revealed a lighter belly coloration that graded into the dark, grey-black of the upper surfaces. Most animals had a dark mask on the lower face, starting above the eyes, and also a short, dark cape below the dorsal fin. As the school turned, individuals in the lead were seen to wait, raft, and turn, allowing the main body to catch up. Small groups could be seen going different directions within the school. They paced the ship after it returned to course. Sooty terns and wedge-tailed shearwaters were nearby. The second sighting occurred within a school of 350 *Lagenodelphis*. The *Feresa/Peponocephala* were seen rafting on the edge of the school of Fraser's dolphin each time the school slowed. A dark band extending from the face and eye and extending toward the rear was seen in these *Feresa/Peponocephala*, a coloration not noted in the first school described above.

Lagenodelphis hosei (Fraser's dolphin), Figure 7

Though not common, this small dolphin is regularly sighted in equatorial waters. There were four schools of *Lagenodelphis* sighted with school size ranging from 75 to 350. None were with birds, and all but one were pure schools. The mixed school included the small band of *Feresa/Peponocephala* mentioned above. *Lagenodelphis* characteristically bunch tightly when running. They have a remarkable ability to turn quickly as a group, even making 180° turns. They run relatively low in the water, creating much splashing, but frequently charge clear of the water in bursts of speed. One school was seen to submerge entirely, reappearing again after about 20 seconds, all while running at full speed. Younger individuals tend to lag behind during a long run. During some of the sightings individuals were seen in the distance performing high, parabolic leaps, side flops, and "spy-hopping" maneuvers. Much individual variation in color pattern was noted. The larger animals often had a bold, black stripe from eye to anus that circled under the belly over a ventral keel. Younger animals tended to a washed-out grey with pinkish bellies. Dorsal fins ranged from falcate to triangular, the latter mostly in the larger animals.

Pseudorca crassidens (false killer whale), Figure 7

Four false killer whale schools were sighted. School size ranged from 12 to 35. There were no birds or other dolphin species with the whales. These animals were usually sighted jumping, splashing or somersaulting in the distance. Some schools approached the ship, even bow riding. Others ran in a widely scattered arc ahead of the ship before grouping loosely about the vessel. The schools were comprised of smaller groups swimming tightly together.

Tursiops truncatus (bottlenose dolphin), Figure 8

There were nine sightings of this species. All but one sighting occurred in the seasonally warmed subtropical water southeast of the Galapagos Islands. There were no sightings north of or along 10°N as in 1976. Three schools were accompanied by pilot whales (*Globicephala*). One school was associated with three birds (*Puffinus, Pterodroma, Oceanodroma*). School size ranged from 12 to 180. Most schools were rafting or moving slowly when approached. Several were sighted when individuals jumped clear of the water. Schools tended to be composed of loosely scattered groups. Some approached the ship and bow rode; others avoided the ship by changing course.

Globicephala macrorhyncus (short-finned pilot whale), Figure 8

Twenty-five schools of *Globicephala* were sighted. Excluding three schools mixed with *Tursiops*, the school sizes ranged from 1 to 35. As in 1976 the *Globicephala* sightings occurred all along the equatorial belt. These small whales were often sighted as they crossed the ship's path, seemingly unperturbed. Others were seen when individuals jumped, splashed, or "spy-hopped." Some schools were rafting when approached, and several sounded when the ship neared.

Ziphius cavirostris (goosebeaked whale), Figure 10

This species was recognized by its reddish-brown coloration and whitish head parts. Six sightings were recorded with school sizes ranging from 1 to 7. *Ziphius* were seen in the California Current, the Tropical Surface Water north of the equator, and in the coastal waters off Ecuador-Peru. This medium-sized whale was usually seen rafting or moving slowly. One was seen to breach at 2.5 miles distance. When swimming they may dive shallowly several times. They tend to disappear quietly.

Physeter catadon (sperm whale), Figure 10

The sperm whale is a common whale of the equatorial belt of the eastern tropical Pacific. Twenty sightings were recorded. School sizes ranged from 1 to 15. The largest schools were off Peru and just to the west of the Galapagos Islands. Sperm whale schools are often composed of widely scattered groups of two to three animals, often seen swimming side by side. Several whales were seen breaching with the body half out of the water.

Balaenonoptera sp. (rorquals), Figure 11

This group includes *B. musculus, B. physalus, B. borealis,* and probably *B. edeni* and *B. acutorostrata.* We were not able to distinguish these species in most cases. The 25 sightings of rorquals occurred primarily in the tropical waters along the equatorial belt, but there was one sighting (*B. musculus*) off the coast of Peru and two sightings in the vicinity of the thermocline ridge at 10°N.

Mesoplodon and other small-to-medium unidentified whales, Figure 11

Thirty-six sightings fell into this group (Table 14 without *Ziphius*). At least 21 were very likely species of *Mesoplodon*, or beaked whales. These are relatively small, grey-brown whales with a falcate dorsal fin behind the mid-body. They are usually seen singly or in pairs and they characteristically move slowly, sinking or diving quietly out of sight on approach of the ship. They were usually first sighted moving slowly along the surface, but a few were initially jumping or splashing.

In one positively identified *Mesoplodon* school, the animals approached the ship via a series of shallow dives; they surfaced with their beaks open, the top of their bulbous heads breaking the surface first. Individual coloration varied from light-grey to grey-brown. If most of these small, brownish whales were *Mesoplodon*, then the beaked whales are one-of-the-most-common whales of the equatorial eastern Pacific.

2. Birds (Figures 12-14)

The abundance of sea birds increased markedly upon entering the tropical and more-southerly waters. Storm petrels, especially *Oceanodroma leucorhoa*, were abundant along the thermocline ridge just north of 10°N and much more so along the equatorial belt. East of 90°W this storm petrel species was increasingly replaced by *O. thethys*, *O. hornbyi*, and *O. melania/markhami*. White-necked/Juan Fernandez petrels (*Pterodroma externa*) were encountered mainly between 15°N and the equator and west of 105°W (Fig. 12). East of 105°W these petrels were replaced by *P. phaeopygia*, the dark-rumped petrel, which was especially abundant south and southeast of the Galapagos Islands. Sooty terns were abundant in the subtropical water south of the equator (Fig. 13). They were also abundant along the equator, especially in areas of frontal activity. Of the pelagic birds the terns are probably the most symbiotically dependent on surface fish schools. The fact that most sooty tern flocks were not working with mammal schools, even in areas where a thousand of these birds could be seen per day, is an indication that along the equator and other weak thermocline areas, the dolphin-tuna bond is weakened. Black terns (*Chilidonias niger*) replaced the sooty terns in the coastal waters of Peru-Ecuador. Figure 14 describes the marine mammals seen with the sea birds.

3. Squids (Figure 15)

Over 450 *Ommastrephid* squid of the species *Dosidicus gigas* and *Symplectoteuthis oualaniensis* were taken by jig and dip-net. Members of other families were also captured in the Isaacs-Kidd and Manta nets. A key of sexual maturity was developed for the *Ommastrephid* squid after studying many specimens aboard ship. Thereafter all *Dosidicus* and *Symplectoteuthis* were measured, sexed, and scaled according to the maturity scale. Specimens were also frozen for later studies on growth. Both species were widespread, but *Dosidicus* was especially abundant in equatorial waters.

Most *Dosidicus* were sexually immature. This was not the case with *Symplectoteuthis*. *Ommastrephid* squids were abundant in areas of sea bird and marine mammal activity and are possibly the most important, common forage resource of the mammal-bird-tuna system.

4. Oceanography

Oceanographic measurements consisted of 239 XBT profiles and continuous recordings of surface temperature, salinity, and chlorophyll. It is clear that there are two important oceanographic regimes involved in dolphin distributions. One is the Tropical Surface Water underlain by a shallow and sharp thermocline that stretches to the west near 10°N. This is the main habitat of the tropical dolphins. The second oceanographic regime is the Equatorial Water along and about the equator. Here the thermocline is shallow but weak. It is a region of upwelling and convergence, and, in areas where Subtropical Surface Water to the south abut strongly against the Equatorial Water, frontal activity. Many of the marine mammal sightings occurred near such areas. The boundary between the Equatorial and Subtropical water shifted markedly between the first and second half of the cruise. The study of the movement of these fronts will therefore be important in delineating the habitat of tropical dolphins. The distribution of dolphins in the equatorial waters stretched beyond 125°W in 1977. In comparison, few marine mammals were seen west of 110°W in the 1976 surveys. This may be related to the El Niño conditions of late 1976 which brought about greater warming in 1977 along the equator and elsewhere.

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

RECOMMENDATIONS AND COMMENTS:

The *D. S. Jordan* is an excellent platform for sighting marine mammals and studying related ecological aspects, including behavior, trophic relationships, and environmental effects. Future surveys should continue to integrate ecological studies.

Behavioral information is needed both to correctly interpret sighting data from these surveys and to assess the effects of the tuna fishery on dolphin populations. However, behavioral observations during the surveys are limited by the disturbing effects of the vessel itself. To learn about the behavior of undisturbed schools it will be necessary to use a helicopter or sailboat. Trans-equatorial cruising yachts may prove to be useful observational platforms. A practical approach that could be integrated into a regular survey would be to allot several days for cruising at half, or less, speed. Such low speed cruising would be less disturbing to marine mammals and could be reserved for areas of high mammal concentrations, which should not be difficult to find.

Studies on trophic relationships among sea birds, tuna, and dolphins should be continued, including the squid sampling using the methods developed on this cruise. These studies would contribute to understanding the dolphin-tuna bond and why flocking sea birds appear to be weakly associated with dolphins in equatorial and central Pacific waters.

Oceanographic studies should be an integral part of the surveys and should be expanded to include studies of the oxycline. A better understanding of the relationship between dolphin distributions and oceanography will enable more efficient stratifications of population - density estimates, including the effects of temporal changes in distribution. Whether the equatorial distribution as seen during this cruise is typical, in either an annual or seasonal sense, is an important question.

SCIENTIFIC PERSONNEL:

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Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Date: 7/15/77 Prepared by: David W. K. Au

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Date: 7/16/77 Approved by: Izadore Barrett

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Center Director

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Table 1. Stenella attenuata

Date	Location		Estimated School Size	Notes
1/19/77	03°58'N	112°47'W	200	w/unidentified dolphins
1/19	03°59'N	112°29'W	1000	w/S. longirostris
1/19	03°59'N	112°29'W	75	w/S. longirostris
1/19	03°21'N	112°21'W	30	w/S. longirostris
1/22	04°56'S	111°58'W	1000	w/200 Sooty Terns
1/23	03°58'S	106°33'W	1500	w/S. longirostris, 225 Sooty Terns, 20 White Terns
2/12	06°12'S	084°54'W	175	w/2 Frigate birds
2/12	06°48'S	085°33'W	35	Possible sighting w/S. longirostris
2/14	04°25'S	091°03'W	200	w/S. longirostris, 8 Sooty Terns, 1 Dark Rumped Petrel
2/15	06°34'S	093°46'W	300	w/150 Sooty Terns, 5 Frigate birds
2/18	06°34'S	102°12'W	100	w/S. longirostris
2/20	00°39'N	104°46'W	350	w/1 Frigate, 1 Wedge Tailed Shearwater
2/20	00°55'N	104°57'W	125	
2/21	00°15'N	107°25'W	60	
2/25	01°26'N	118°27'W	60	
2/25	01°32'N	118°27'W	75	
2/25	01°40'N	118°28'W	20	
2/25	01°54'N	118°31'W	100	w/1 Frigate bird
2/25	02°35'N	118°41'W	75	w/S. longirostris
2/26	04°42'N	120°14'W	250	w/S. longirostris, 1 Sooty Tern
3/1	10°13'N	117°43'W	800	w/S. longirostris, 10 White Necked Petrels, 10 Wedge Tailed Shearwaters, 3 Frigates

Table 2. Stenella longirostris

Date	Location		Estimated School Size	Notes
1/10/77	12°21'N	125°09'W	150	Eastern type
1/18	03°06'N	114°50'W	150	
1/19	03°59'N	112°29'W	1000	w/S. attenuata
1/19	03°59'N	112°29'W	75	w/S. attenuata
1/19	03°21'N	112°21'W	30	w/S. attenuata
1/23	03°58'S	106°33'W	1500	w/S. attenuata, 225 Sooty Terns, 20 White Terns
1/27	05°31'S	096°36'W	200	w/S. coeruleoalba
1/29	11°30'S	093°48'W	600	w/75 Sooty Terns, 12 Frigates
1/30	11°35'S	091°39'W	750	w/fish, 100 Sooty Terns, 12 Pterodroma Petrels, 2 Frigates
1/30	11°43'S	091°29'W	1300	w/YF tuna, Dark Rumped Petrel Sooty and White Terns
1/31	11°44'S	088°44'W	800	w/fish, Dark Rumped Petrels, Sooty and White Terns
2/12	06°48'S	085°33'W	35	w/unid. dolphins (possibly S. attenuata)
2/14	04°25'S	091°03'W	200	w/S. attenuata, 8 Sooty Terns 1 Dark Rumped Petrel
2/18	06°34'S	102°12'W	100	w/S. attenuata
2/16	08°36'S	096°45'W	200	w/unid. dolphins, 5 Sooty Terns, 6 Frigates
2/16	08°43'S	097°04'W	600	w/S. coeruleoalba
2/19	03°25'S	103°27'W	55	w/S. coeruleoalba
2/25	02°35'N	118°41'W	75	w/S. attenuata
2/26	04°42'N	120°14'W	250	w/S. attenuata, 1 Sooty Tern
3/1	10°13'N	117°43'W	800	w/S. attenuata, 10 White-Necked Petrels, 10 Wedge-Tailed Shearwaters 3 Frigates
3/2	13°15'N	119°00'W	100	Eastern type with unid. dolphins, 25 Sooty Terns, 20 Pterodroma Petrels, 7 Wedge-Tailed Shearwaters

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Table 3. *Stenella coeruleoalba*

Date	Location		Estimated School Size	Notes
1/16/77	00°25'S	122°23'W	30	w/75 Sooty Terns
1/18	02°29'N	116°10'W	20	w/6 Sooty Terns
1/19	03°58'N	112°28'W	90	
1/19	03°37'N	112°42'W	25	
1/26	01°34'S	097°51'W	400	
1/26	02°17'S	097°33'W	30	w/unid. dolphins
1/27	05°31'S	096°36'W	200	w/*S. longirostris*
2/12	06°59'S	085°52'W	25	
2/13	05°04'S	088°33'W	75	
2/13	05°05'S	088°41'W	40	w/1 Frigate
2/16	08°43'S	097°04'W	600	w/*S. longirostris*
2/18	05°54'S	102°30'W	30	
2/19	03°25'S	103°27'W	55	w/*S. longirostris*
2/20	00°37'N	104°45'W	60	
2/22	01°05'S	112°29'W	25	
2/23	01°58'S	114°14'W	400	
2/23	02°50'S	115°41'W	30	
2/24	01°40'S	117°23'W	15	
2/24	01°28'S	117°30'W	30	

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Table 4. Delphinus delphis

Date	Location		Estimated School Size
1/6/77	25°59'N	121°27'W	100
2/11	05°38'S	083°09'W	1200
2/11	05°35'S	083°16'W	45
2/12	06°39'S	085°24'W	300
3/5	24°16'N	118°01'W	20
3/6	28°03'N	117°49'W	450
3/7	30°14'N	117°31'W	75
3/7	30°17'N	117°28'W	25
3/7	30°56'N	117°21'W	20
3/7	31°00'N	117°21'W	1
3/7	31°10'N	117°19'W	5
3/7	31°18'N	117°14'W	4

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Table 5. Grampus griseus

Date	Location		Estimated School Size	Notes
1/15/77	00°54'S	124°15'W	30	w/unid. dolphin
1/26	01°35'S	097°48'W	8	
2/10	09°09'S	080°32'W	75	w/unid. dolphin
2/10	08°43'S	080°58'W	5	
2/10	08°10'S	081°10'W	1	
2/11	06°07'S	082°41'W	25	
2/11	05°50'S	082°52'W	15	
2/13	05°30'S	087°47'W	3	
2/13	05°12'S	088°17'W	35	w/Frigate bird
2/13	05°04'S	088°45'W	4	
2/16	08°15'S	095°50'W	3	
2/22	00°55'S	111°51'W	5	
2/25	02°05'N	118°33'W	5	
3/5	22°42'N	118°08'W	5	
3/5	23°31'N	118°04'W	10	
3/7	31°01'N	117°21'W	6	

Table 6. Steno bredanensis

Date	Location		Estimated School Size	Notes
1/16/77	00°08'S	121°50'W	25	
1/26	01°38'S	098°16'W	8	
2/21	00°15'S	109°09'W	15	
2/25	01°54'N	118°31'W	12	

Table 7. Orcinus orca

Date	Location		Estimated School Size	Notes
2/18/77	07°08'S	101°45'W	8	
2/21	00°12'S	108°55'W	5	

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Table 8. *Feresa/Peponocephala*

Date	Location		Estimated School Size	Notes
2/23/77	02°41'S	115°24'W	370	
2/25	02°29'N	118°39'W	350	w/*Lagenodelphis*

Table 9. *Lagenodelphis hosei*

Date	Location		Estimated School Size	Notes
2/14/77	04°06'S	090°42'W	75	
2/23	01°58'S	114°14'W	175	
2/25	01°29'N	118°27'W	350	
2/25	02°29'N	118°39'W	350	w/*Feresa/Peponocephala*

Table 10. *Pseudorca crassidens*

Date	Location		Estimated School Size	Notes
1/31/77	11°46'S	087°46'W	35	
2/9	11°01'S	078°47'W	25	
2/14	04°34'S	091°24'W	20	
2/25	02°18'N	118°37'W	12	w/6-8 *Pterodroma* petrels

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Table 11. Tursiops truncatus

Date	Location		Estimated School Size	Notes
2/3/77	11°58'S	078°20'W	50	
2/11	05°52'S	082°50'W	12	w/Pterodroma petrel, shearwater storm petrel
2/11	05°40'S	083°03'W	30	
2/11	05°35'S	083°16'W	15	
2/12	06°16'S	085°01'W	60	w/Globicephala
2/12	06°21'S	085°13'W	50	
2/14	04°06'S	090°42'W	180	
2/14	04°56'S	088°50'W	50	w/Globicephala
2/20	00°02'S	104°31'W	30	w/Globicephala

Table 12. Globicephala macrorhynchus

Date	Location		Estimated School Size	Notes
1/10/77	12°54'N	129°39'W	6	
1/18	02°53'N	115°18'W	15	
1/19	03°58'N	112°39'W	35	
1/19	03°52'N	112°25'W	12	
1/23	04°20'S	107°28'W	15	
1/25	02°08'S	100°25'W	12	
1/26	02°24'S	097°31'W	18	
1/26	02°30'S	097°30'W	15	
1/27	04°41'S	096°48'W	3	
2/11	05°45'S	082°57'W	1	
2/11	05°35'S	083°16'W	4	
2/12	06°16'S	085°01'W	60	w/Tursiops
2/12	06°38'S	085°21'W	5	
2/14	04°06'S	090°42'W	10	
2/14	04°56'S	088°50'W	50	w/Tursiops
2/18	06°28'S	102°14'W	6	
2/20	00°02'S	104°31'W	30	w/Tursiops
2/20	00°16'N	104°40'W	15	
2/21	00°07'N	108°03'W	10	

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Table 12. Globicephala macrorhynchus (cont)

Date	Location		Estimated School Size	Notes
2/21	00°06'N	108°12'W	6	
2/21	00°06'S	108°39'W	7	
2/21	00°10'S	108°53'W	12	
2/22	01°07'S	112°42'W	10	
2/25	02°05'N	118°33'W	15	
2/27	07°08'N	120°13'W	2	

Table 13. Unidentified Dolphins

Date	Location		Estimated School Size	Notes
1/7/77	23°33'N	122°49'W	25	
1/7	22°25'N	123°27'W	100	
1/9	14°45'N	127°12'W	5	
1/10	12°42'N	125°27'W	3	
1/15	00°51'S	124°08'W	100	
1/16	00°04'S	121°41'W	10	
1/18	02°29'N	116°10'W	20	
1/19	04°00'N	112°57'W	15	
1/19	04°00'N	112°57'W	35	
1/19	03°56'N	112°45'W	25	
1/22	04°52'S	109°13'W	75	
1/25	02°08'S	100°25'W	6	
1/26	01°37'S	098°06'W	2	
2/12	06°27'S	085°13'W	5	
2/13	05°28'S	087°49'W	2	
2/18	06°28'S	102°14'W	6	w/50 Sooty Terns, 1 White Tern
2/20	00°50'N	105°15'W	17	
2/22	00°54'S	111°05'W	6	
2/23	02°15'S	114°34'W	6	
2/23	02°47'S	115°28'W	30	
2/24	01°30'S	117°28'W	2	
2/25	01°15'N	118°27'W	4	
2/25	01°32'N	118°27'W	5	
2/25	02°35'N	118°41'W	50	
3/7	31°10'N	117°19'W	3	

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Table 14. Ziphiid and Small Unidentified Whales

Date	Location		Estimated School Size	Notes
1/6/77	26°34'N	121°06'W	1	
1/13	03°58'N	124°39'W	1	
1/14	00°57'N	125°44'W	1	small-med. whale
1/18	02°38'N	115°27'W	2	
1/18	02°53'N	115°17'W	2	
1/19	03°48'N	112°59'W	2	
1/19	03°56'N	112°27'W	3	Ziphius cavirostris
1/19	03°43'N	112°19'W	1	
1/24	03°36'S	104°45'W	2	Mesoplodon
1/26	01°36'S	098°03'W	1	
1/26	01°36'S	098°03'W	1	
1/26	02°30'S	097°27'W	2	
1/27	04°50'S	096°46'W	2	
1/31	11°45'S	087°55'W	3	small-med. whale
2/10	09°08'S	080°38'W	6	Ziphius?
2/11	05°38'S	083°14'W	1	Ziphius cavirostris
2/11	05°35'S	083°16'W	8	
2/12	06°20'S	085°12'W	1	small-med. whale
2/15	06°18'S	093°32'W	1	
2/17	08°54'S	099°44'W	2	Ziphius cavirostris
2/17	08°25'S	100°16'W	1	small whale or large dolphin
2/18	06°15'S	102°15'W	2	
2/20	00°18'S	104°38'W	1	
2/20	00°53'N	105°00'W	6	
2/21	00°13'N	107°43'W	1	
2/21	00°06'N	108°07'W	1	
2/21	00°14'S	109°02'W	1	
2/22	00°55'S	111°59'W	1	
2/23	02°06'S	114°22'W	1	
2/23	02°11'S	114°27'W	4	small whale or dolphin
2/24	01°32'S	117°26'W	1	
2/24	00°45'S	117°46'W	2	small-med. whale
2/24	00°24'S	117°52'W	4	
2/24	00°24'S	117°53'W	2	Mesoplodon
2/25	01°15'N	118°27'W	1	small-med. whale
2/25	01°15'N	118°27'W	3	
2/25	01°32'N	118°27'W	2	small whale or large dolphin
2/25	02°16'N	118°35'W	1	Ziphius?
2/25	02°17'N	118°35'W	2	small whale or large dolphin
2/25	02°18'N	118°36'W	15	Mesoplodon
2/25	02°18'N	118°36'W	7	Ziphius cavirostris
3/7	30°20'N	117°27'W	2	Ziphius cavirostris

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Table 15. Physeter catadon

Date	Location		Estimated School Size	Notes
1/12/77	05°38'N	123°54'W	4	
1/18	02°27'N	116°11'W	8	
1/19	03°36'N	112°43'W	2	
1/21	02°43'S	110°39'W	2	
1/26	01°40'S	098°25'W	6	
1/26	01°34'S	097°49'W	7	
1/26	01°39'S	097°46'W	6	
1/26	01°55'S	097°41'W	15	
1/26	02°17'S	097°33'W	1	
1/28	07°15'S	095°48'W	6	
2/2	11°52'S	082°43'W	12	
2/9	11°02'S	078°50'W	15	
2/12	06°53'S	085°42'W	10	
2/17	08°44'S	100°00'W	6	
2/19	04°11'S	103°08'W	2	
2/21	00°14'N	107°27'W	3	
2/21	00°14'N	107°32'W	10	
2/22	00°54'S	111°48'W	5	
2/22	01°02'S	112°16'W	1	
2/22	01°02'S	112°18'W	5	

Table 16. Balaenoptera sp.

Date	Location		Estimated School Size	Notes
1/10/77	12°14'N	125°05'W	1	
1/15	00°54'S	123°58'W	1	w/75 Sooty Terns, 10 Wedge Tailed Shearwaters
1/15	00°51'S	123°53'W	2	B. physalus
1/16	00°22'S	122°24'W	2	
1/18	02°52'N	115°20'W	2	B. physalus
1/18	03°06'N	114°50'W	2	
1/18	03°01'N	115°04'W	2	
1/18	03°06'N	114°50'W	1	
1/21	01°42'S	110°49'W	2	w/ 1 Dark-Rumped Petrel
1/25	02°11'S	100°35'W	1	
1/26	01°37'S	098°10'W	2	

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

Table 16. Balaenoptera sp. (cont)

Date	Location		Estimated School Size	Notes
1/26	01°37'S	098°06'W	1	
1/26	01°34'S	097°49'W	1	
2/9	11°03'S	078°32'W	2	*B. musculus*
2/18	06°28'S	102°14'W	1	
2/18	06°15'S	102°15'W	1	
2/19	02°18'S	103°45'W	1	
2/19	02°12'S	103°49'W	2	
2/20	00°52'N	105°08'W	1	
2/21	00°07'N	108°03'W	1	
2/22	01°03'S	112°20'W	1	
2/23	02°29'S	115°16'W	1	
2/24	02°00'S	117°17'W	1	
2/25	02°35'N	118°41'W	2	
3/1	10°08'N	117°35'W	1	

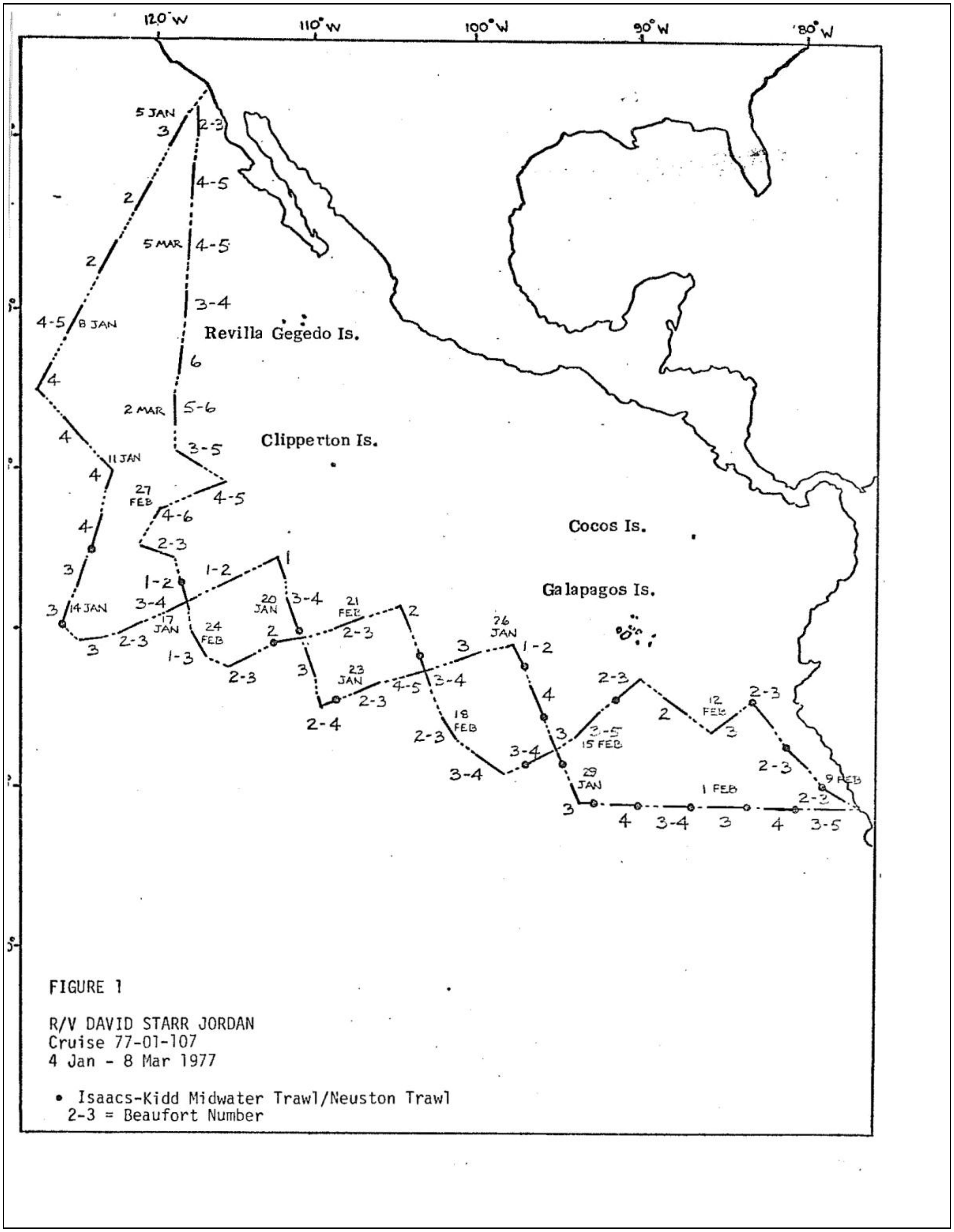
Table 17. Unidentified Medium-Large Whales

Date	Location		Estimated School Size	Notes
1/10/77	12°36'N	125°25'W	1	
1/16	00°04'S	121°41'W	2	
1/18	02°29'N	116°10'W	1	
1/18	02°52'N	115°20'W	1	
1/18	02°54'N	115°15'W	1	
1/19	03°24'N	112°22'W	2	
1/19	03°12'N	112°18'W	2	
1/25	02°24'S	101°14'W	1	
1/26	02°17'S	097°33'W	1	
1/27	05°06'S	096°45'W	1	
1/29	10°20'S	094°30'W	3	
2/2	11°52'S	082°12'W	1	
2/3	11°55'S	079°49'W	2	
2/11	06°00'S	082°45'W	1	
2/18	06°02'S	102°26'W	1	

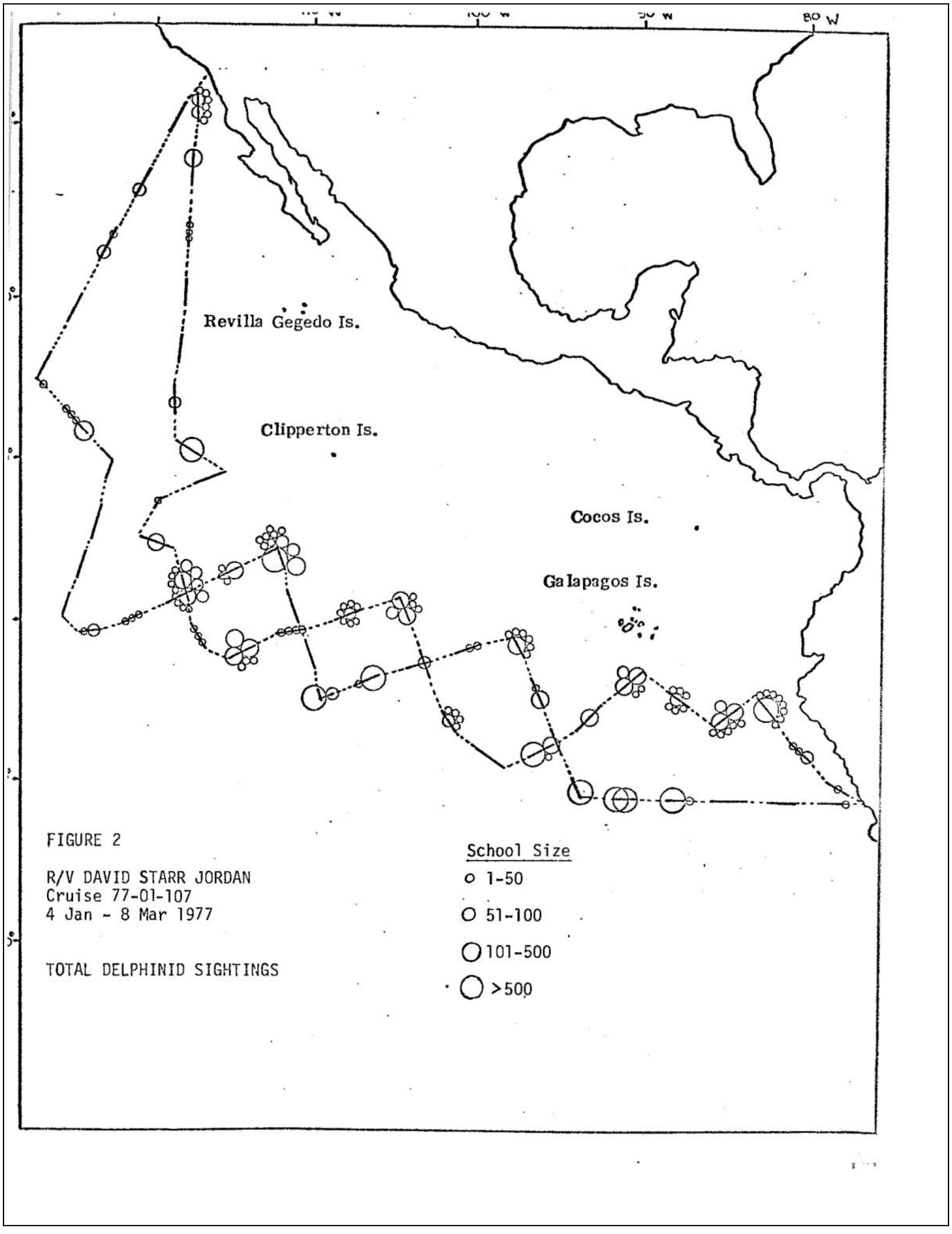
Table 17. Unidentified Medium-Large Whales (cont)

Date Date	Location	Estimated School Size	Notes
2/21	00°17'N 107°18'W	1	
2/22	01°05'S 112°36'W	1	
2/23	02°46'S 115°27'W	1	
2/24	00°41'S 117°47'W	1	
2/24	00°42'S 117°48'W	1	
2/24	00°26'S 117°50'W	1	
2/25	01°27'N 118°27'W	1	
3/5	23°01'N 118°04'W	1	
3/7	30°35'N 117°21'W	1	

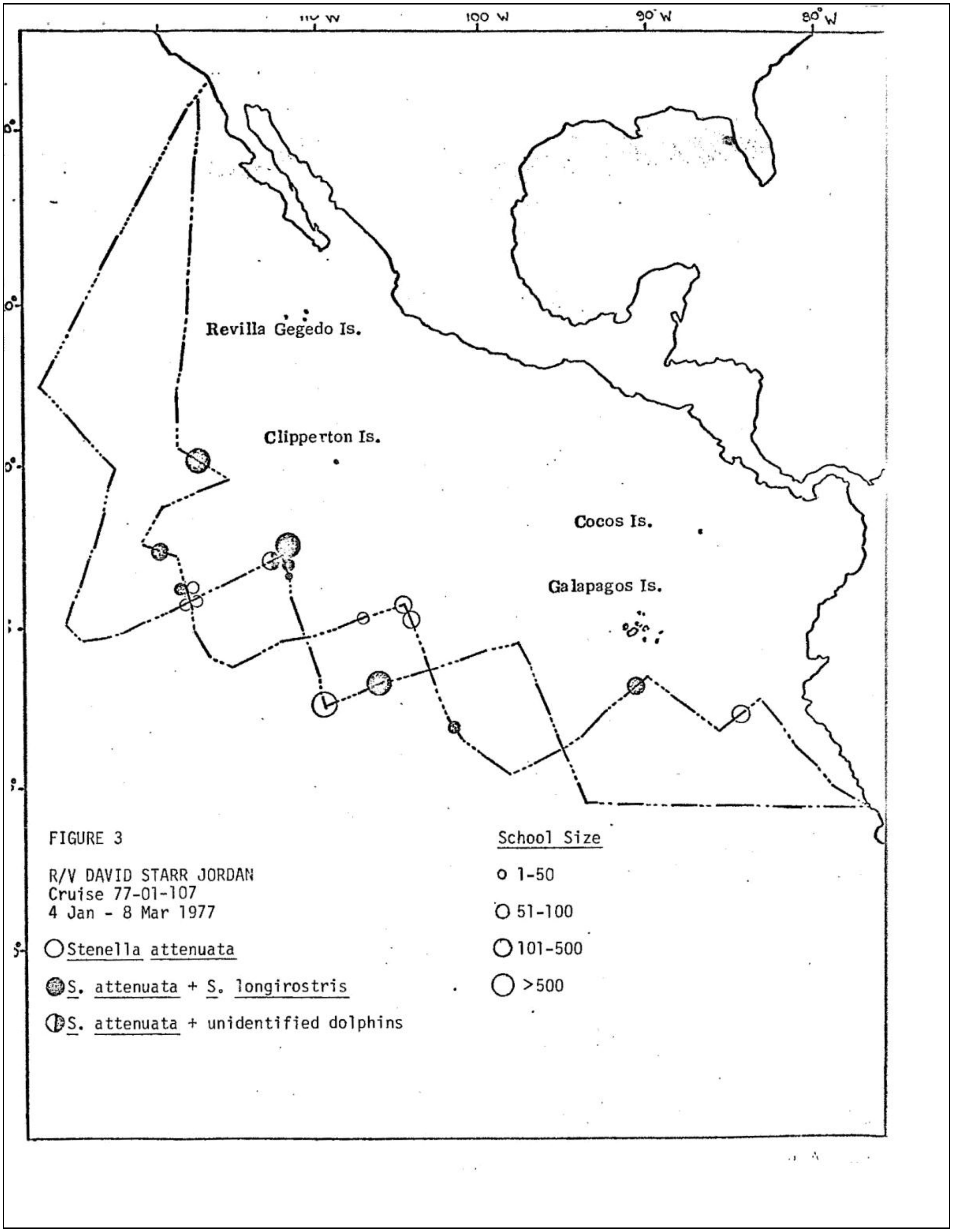
Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



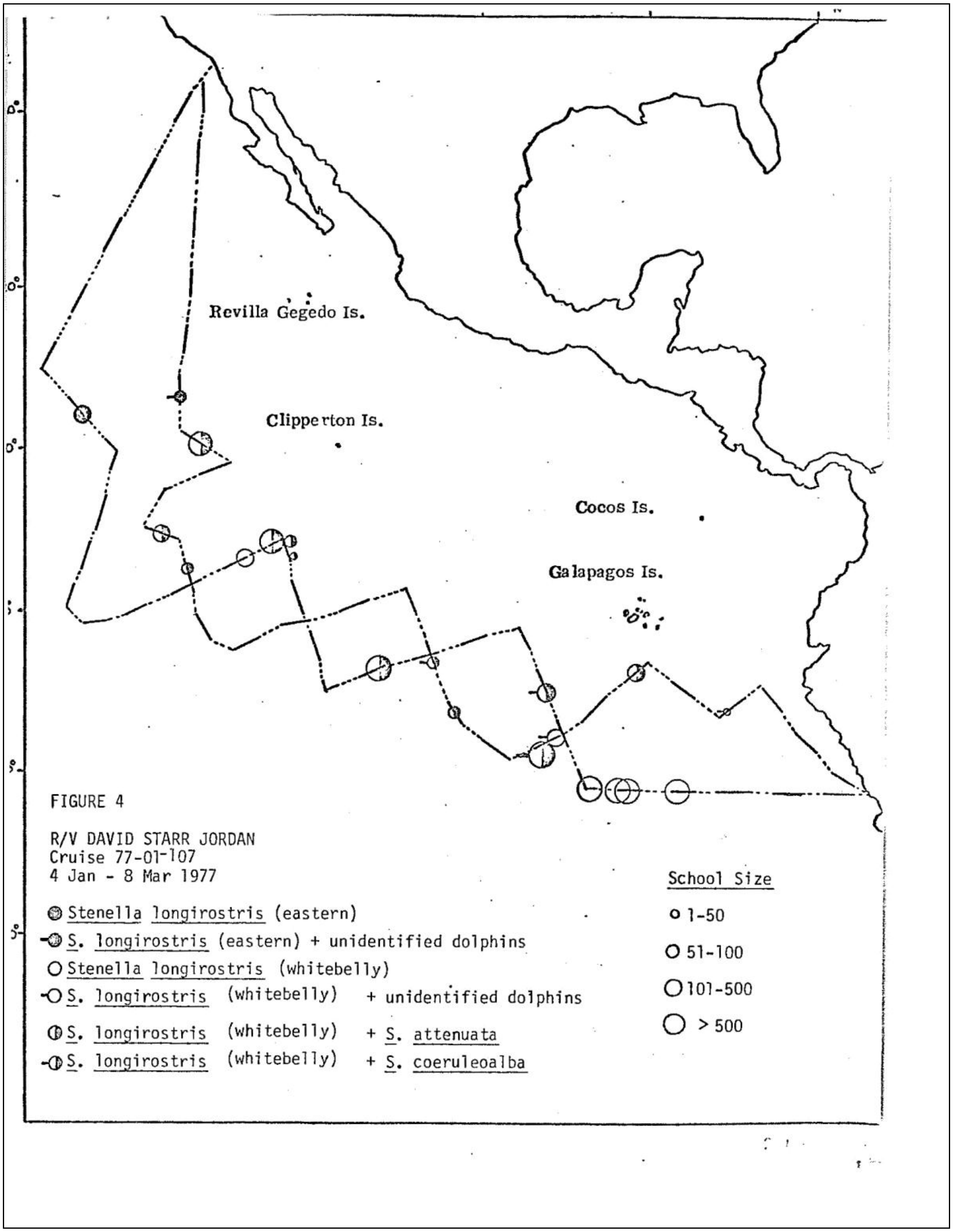
Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

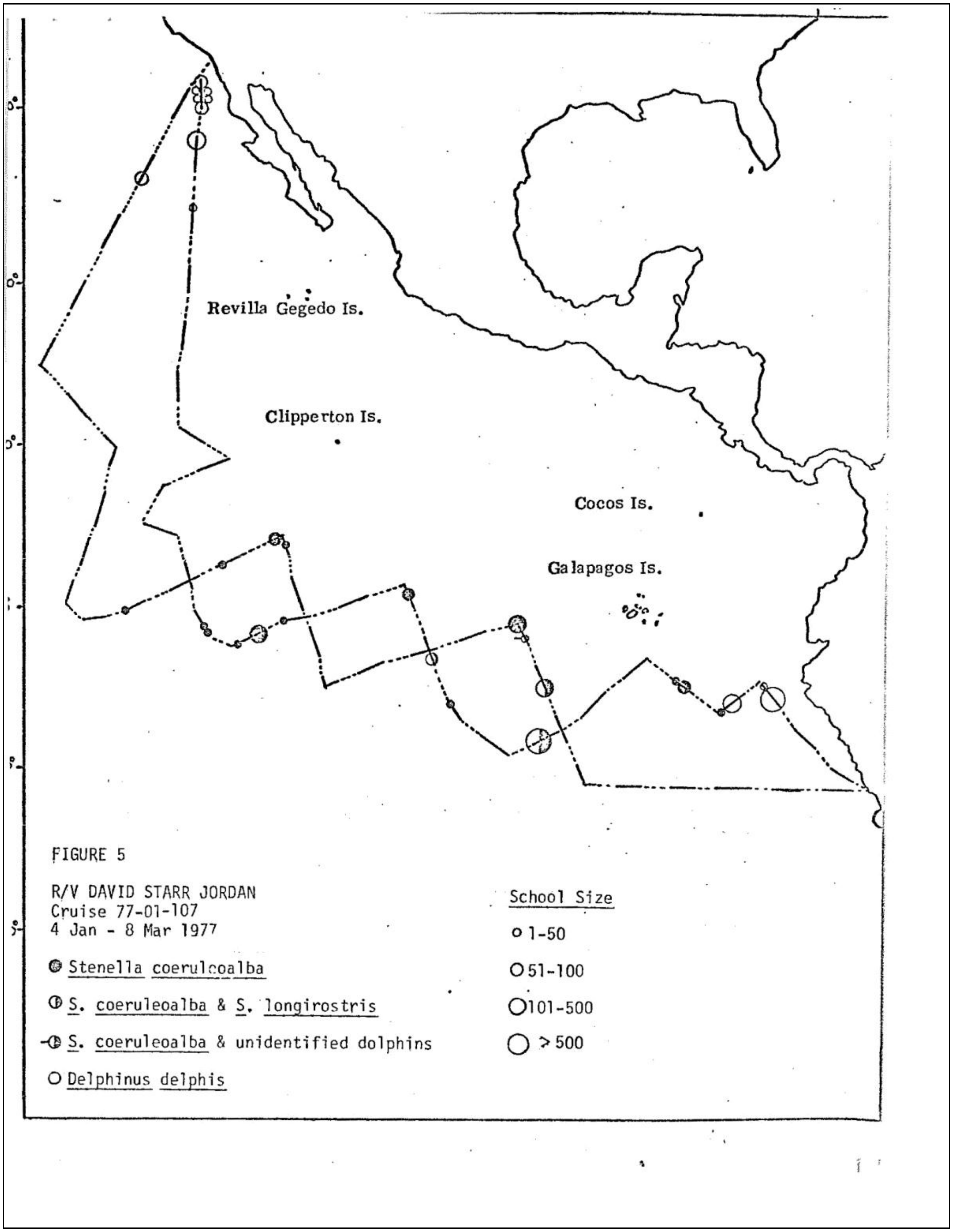
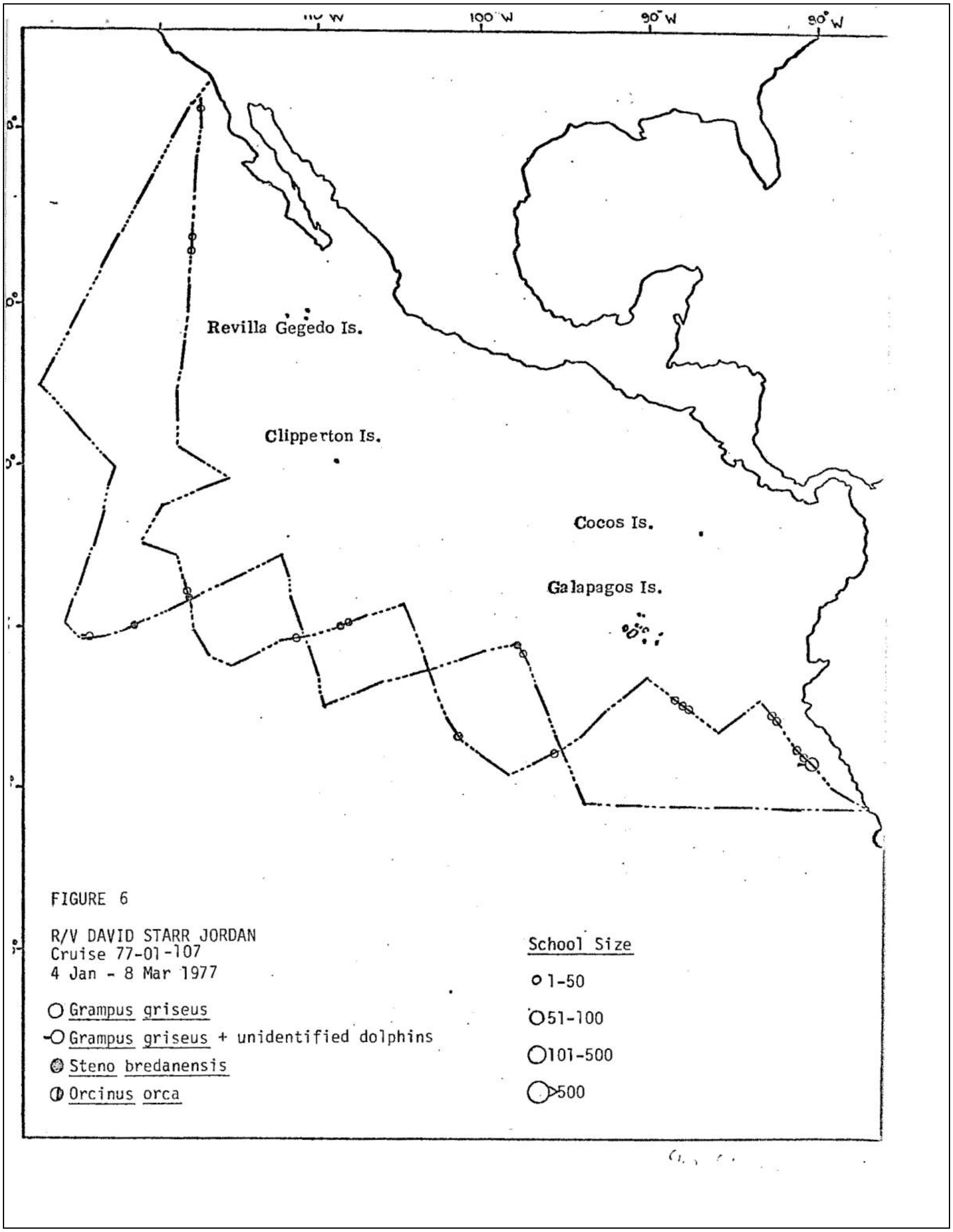


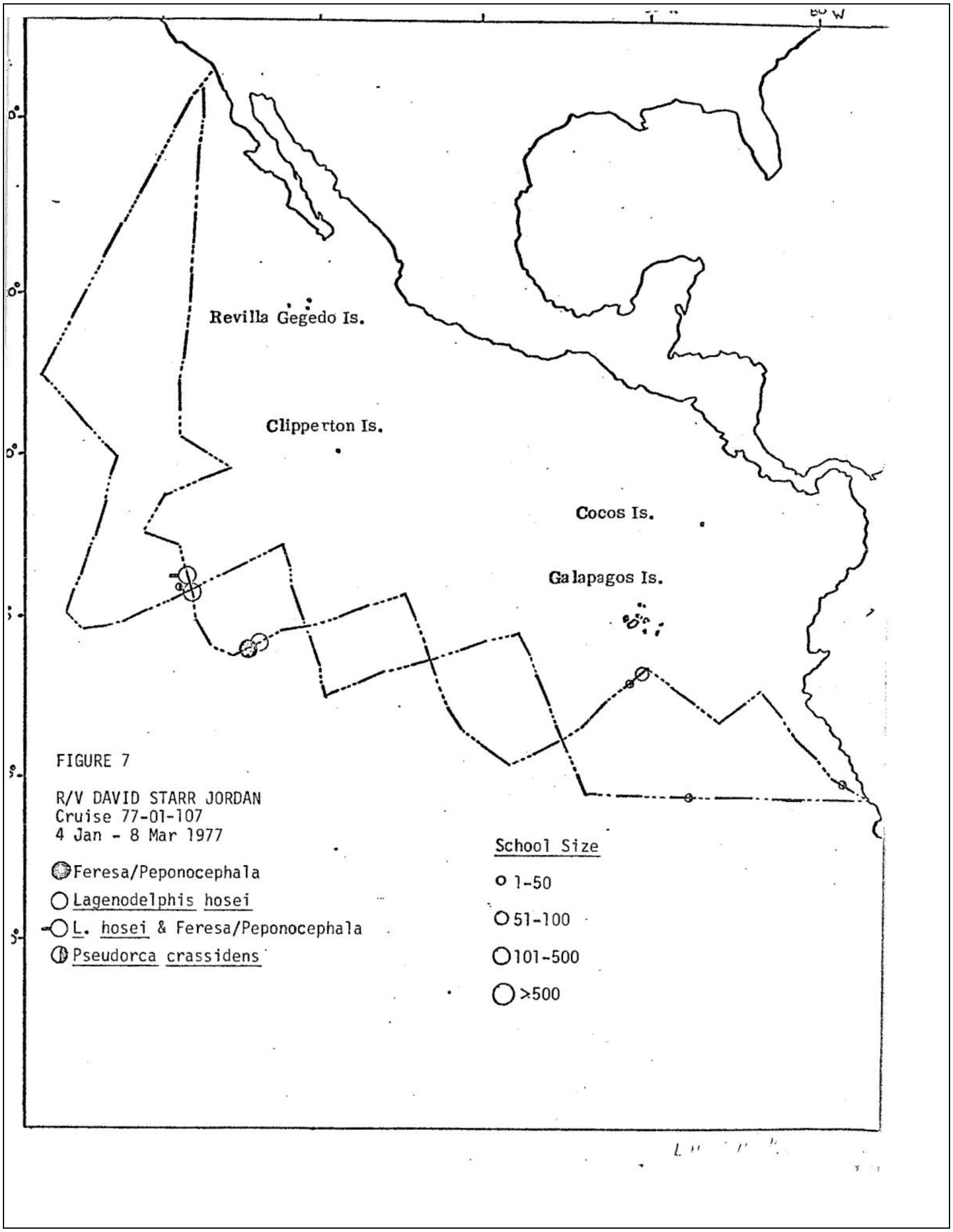
FIGURE 5

R/V DAVID STARR JORDAN
Cruise 77-01-107
4 Jan - 8 Mar 1977

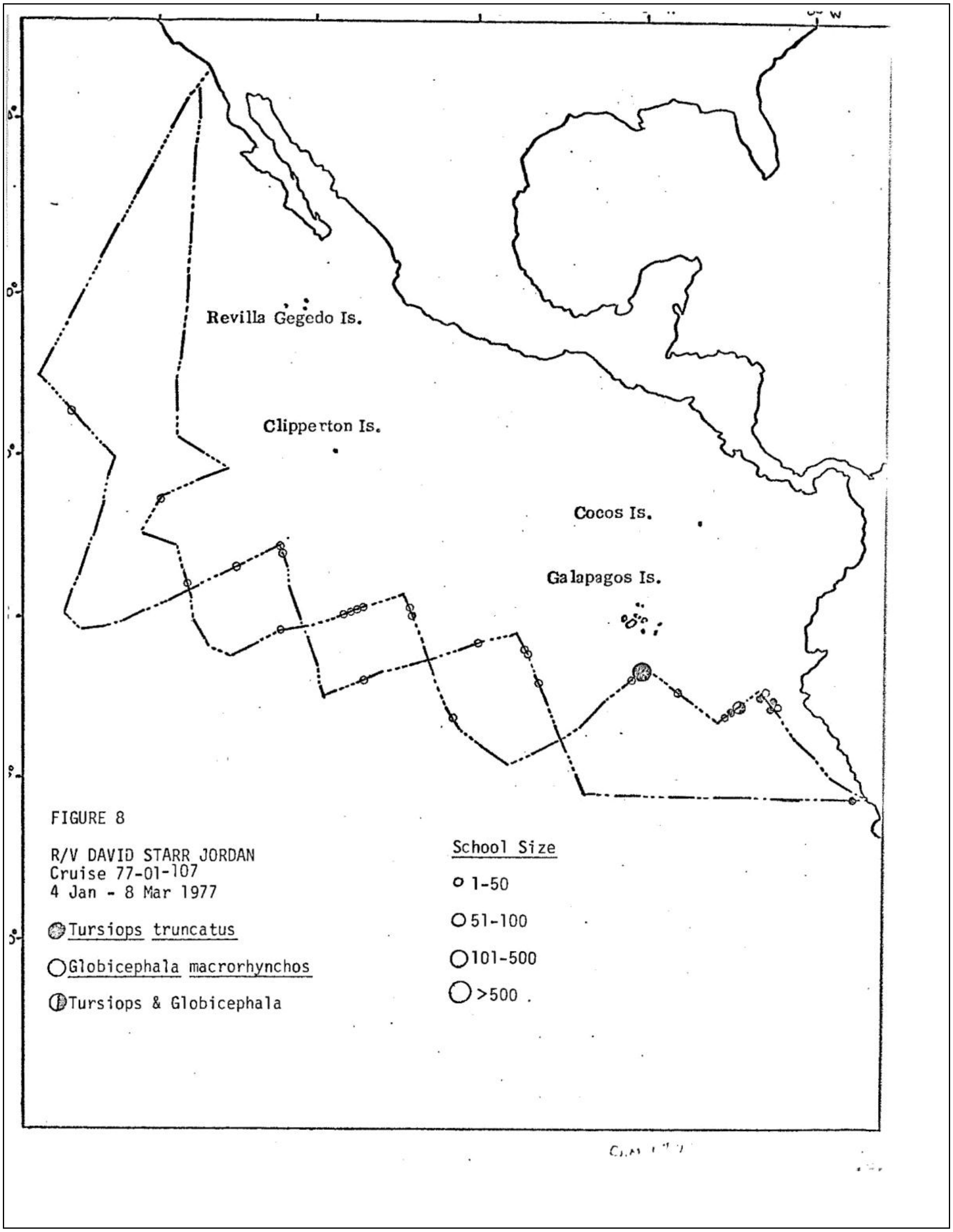
Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



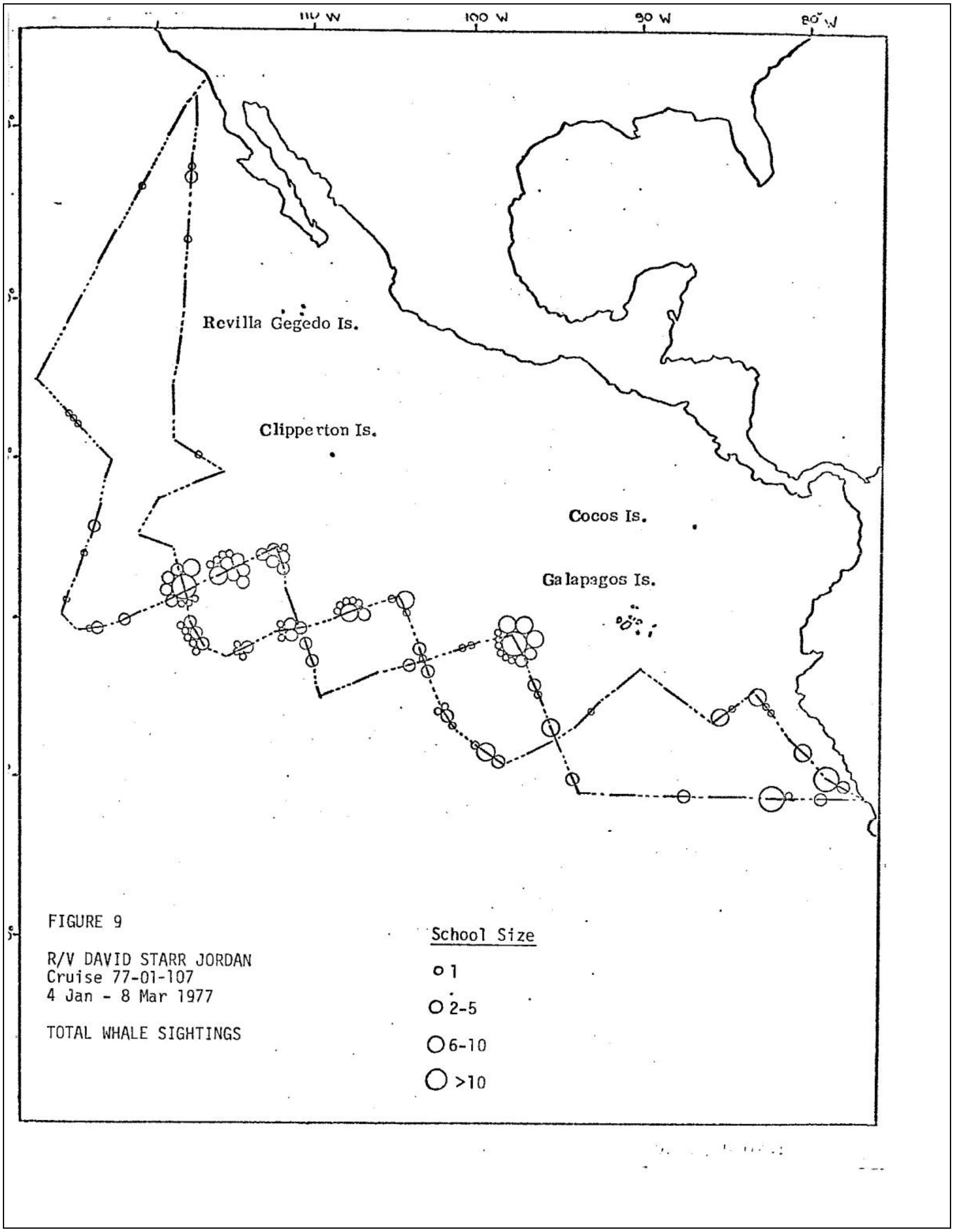
Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



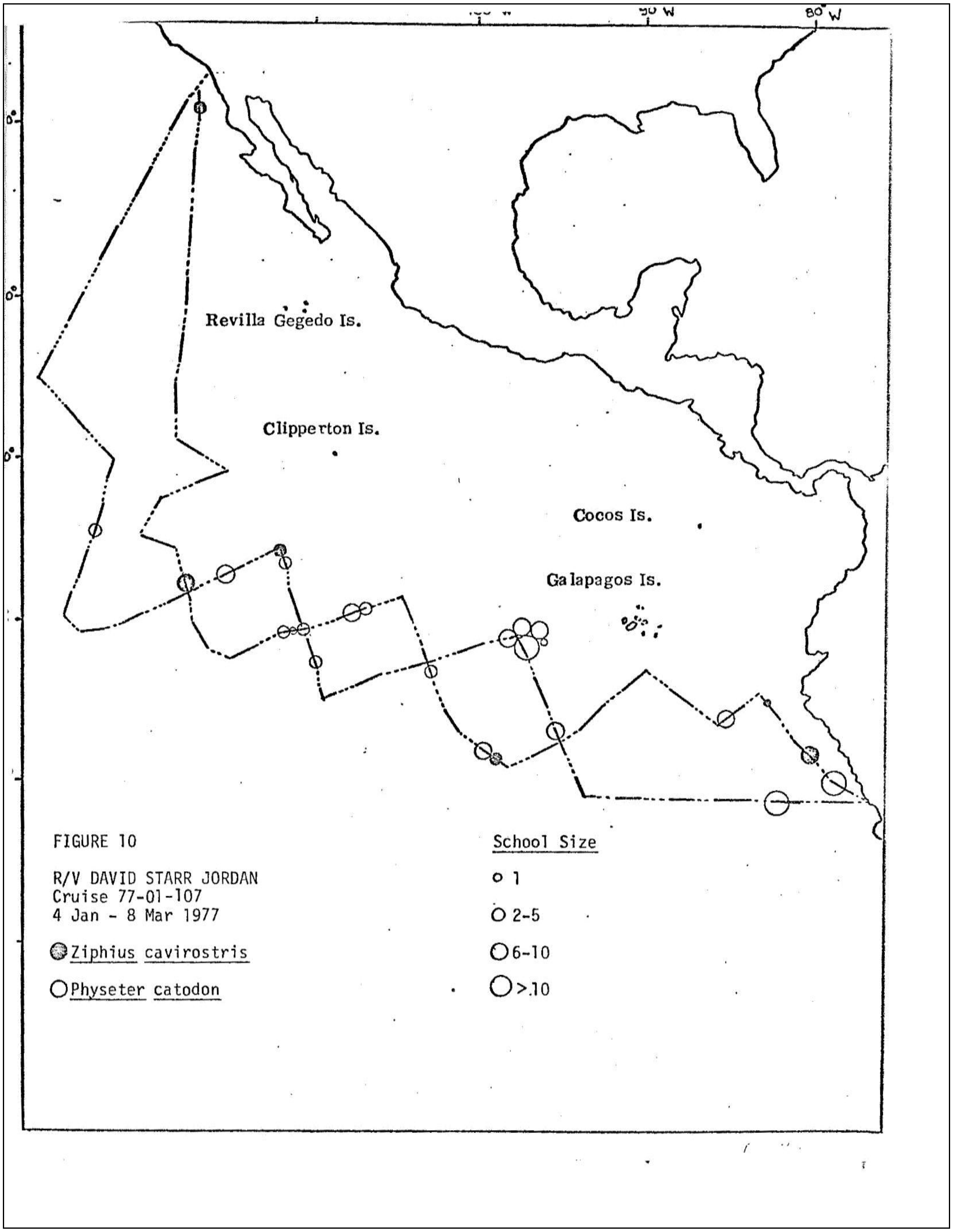
Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



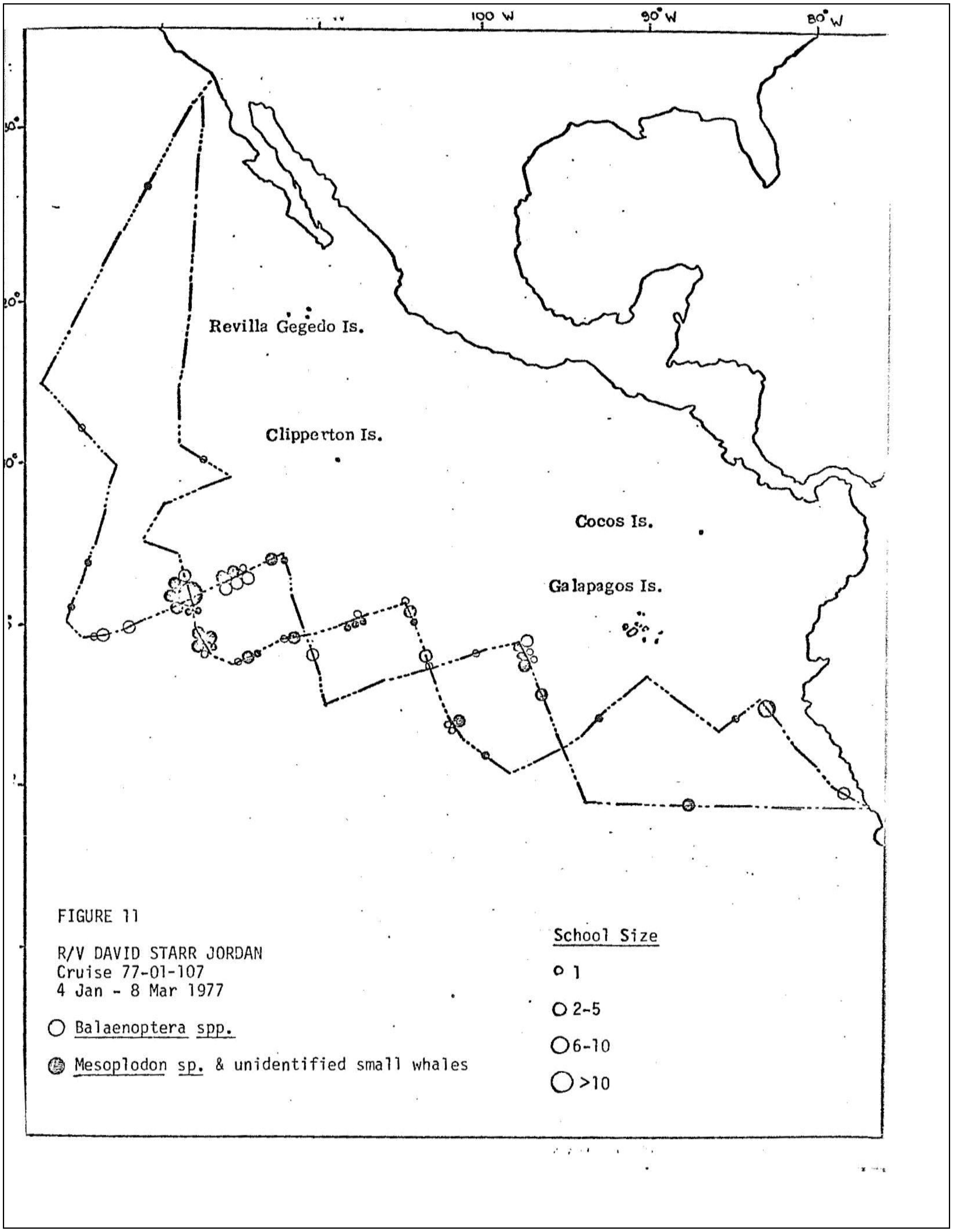
Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



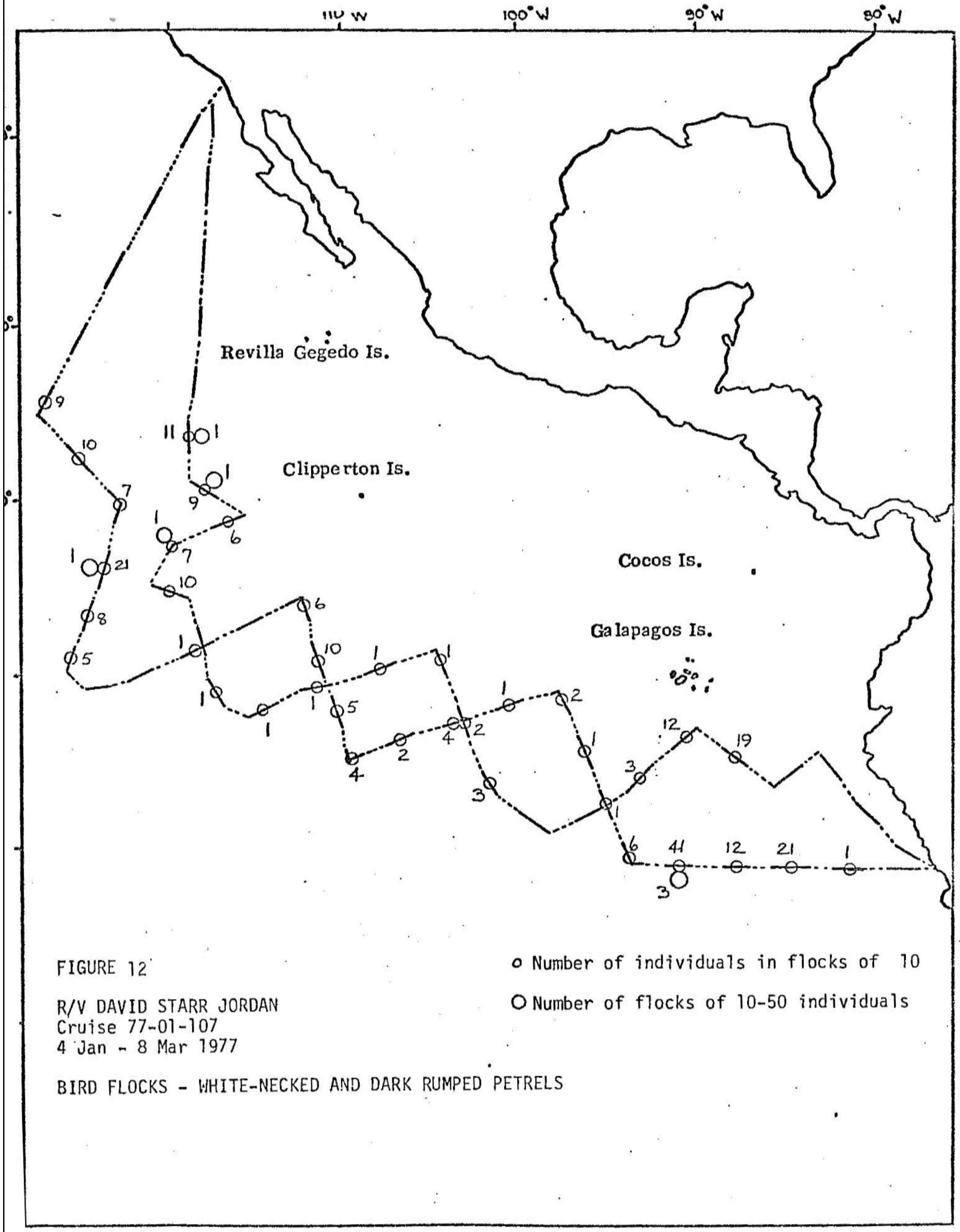
Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)

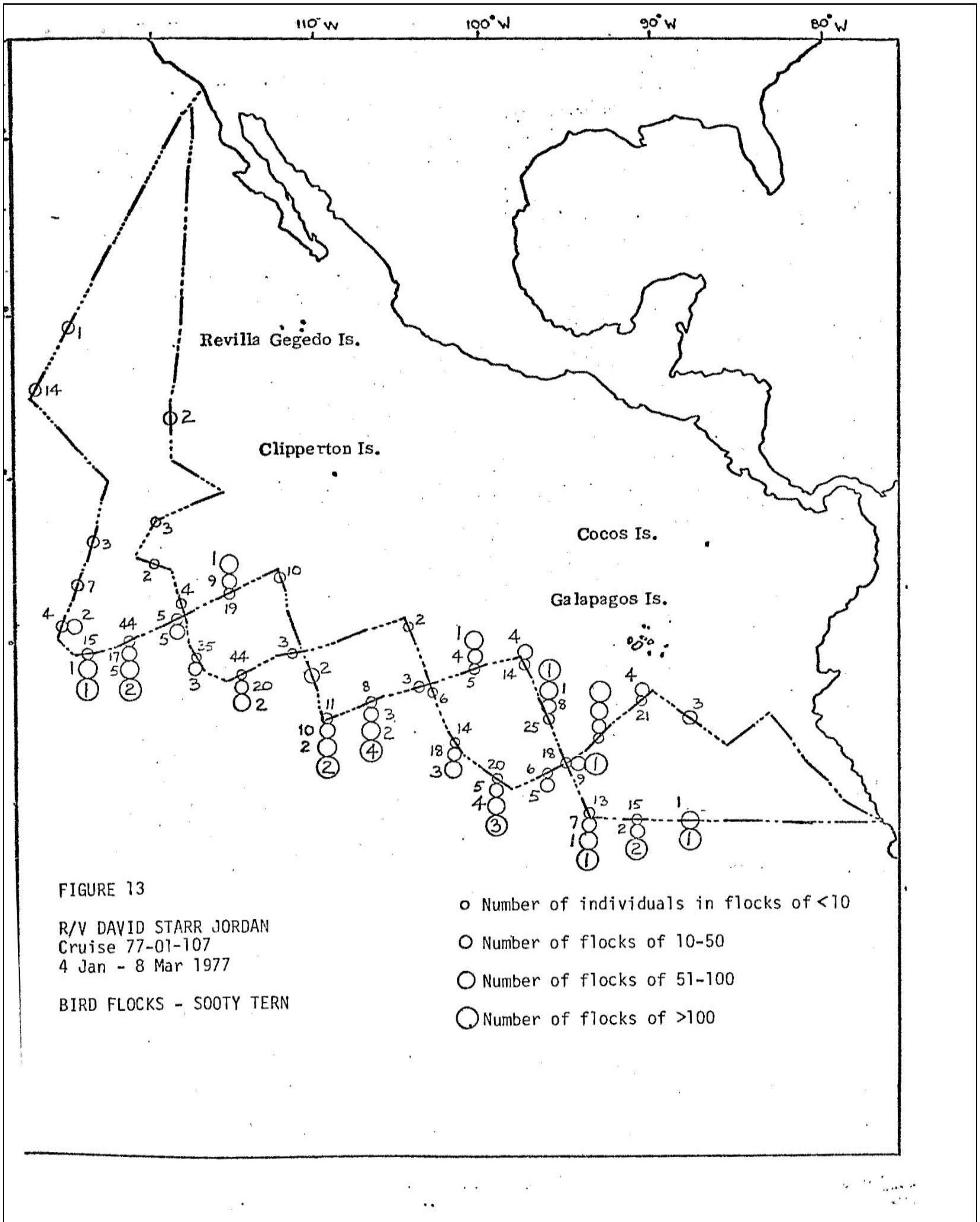
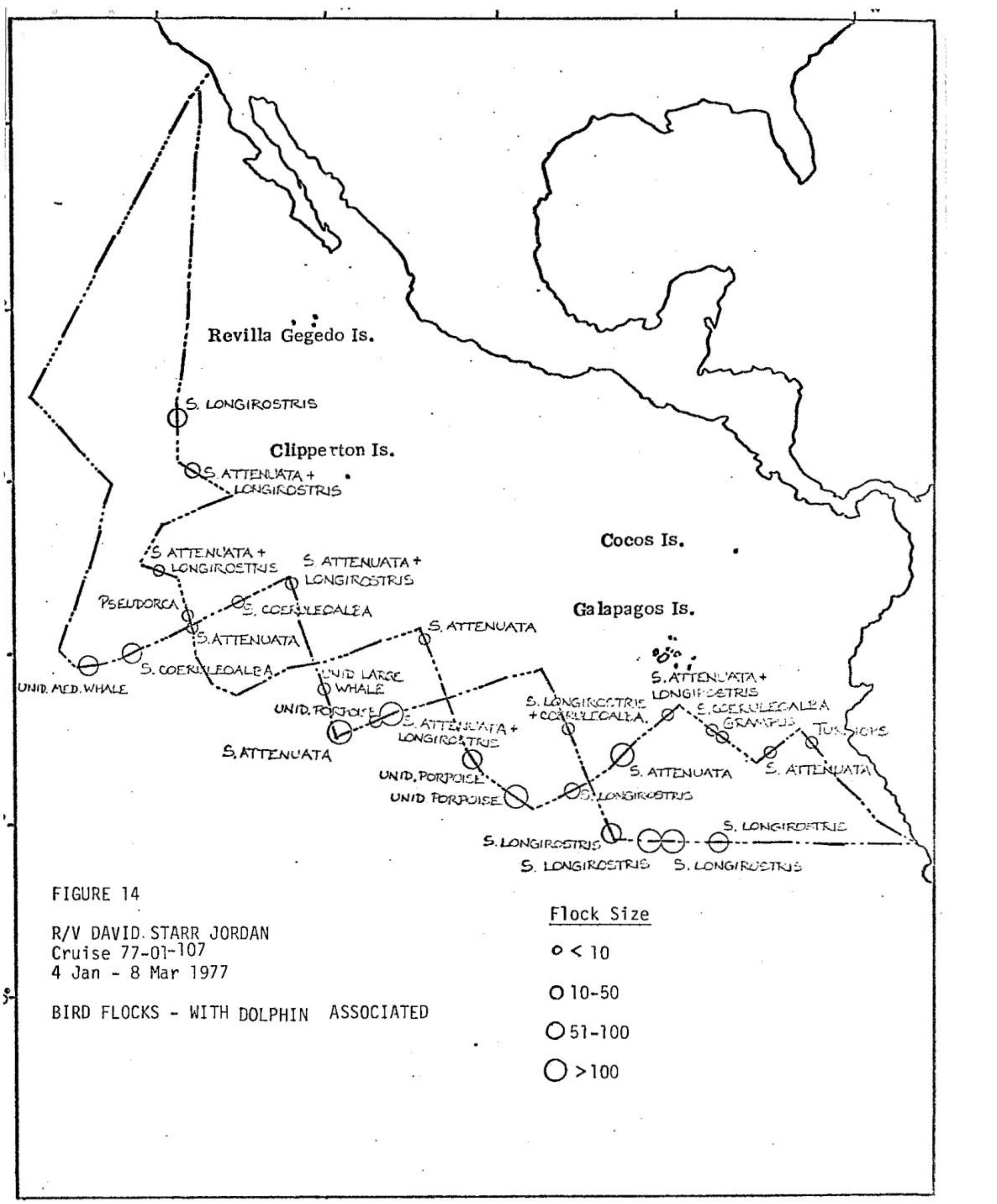


FIGURE 13

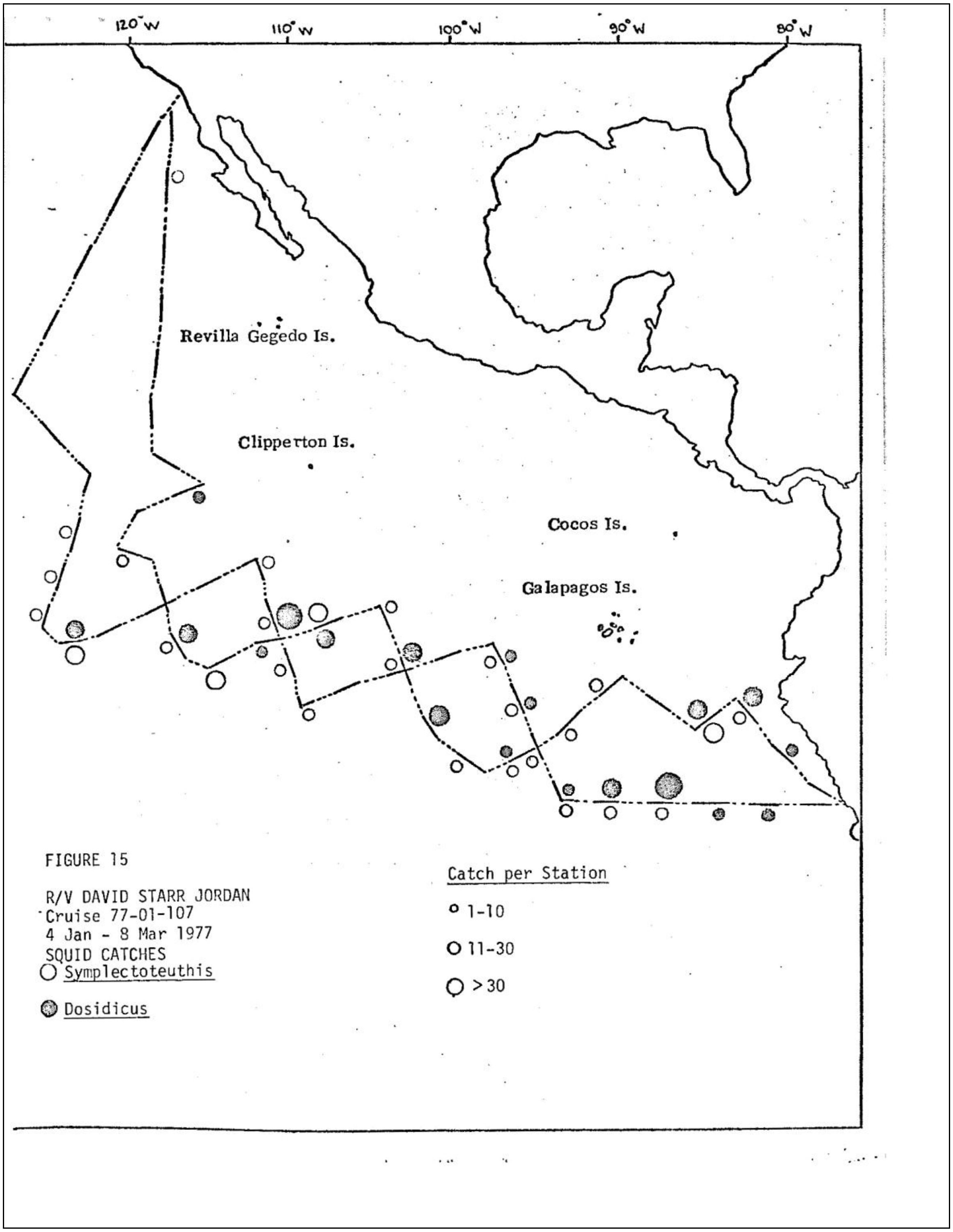
R/V DAVID STARR JORDAN
Cruise 77-01-107
4 Jan - 8 Mar 1977

BIRD FLOCKS - SOOTY TERN

Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



Appendix 2G. Cruise report for SWFSC Cruise 0213. (Continued)



Appendix 2H. Cruise report for SWFSC Cruise 0214.

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Marine Fisheries Service
SOUTHWEST FISHERIES CENTER
La Jolla, California 92038

CRUISE REPORT

VESSEL: NOAA Ship *Townsend Cromwell*, Cruise TC-77-01-74, Porpoise Cruise No. 214.

CRUISE PERIOD: January 6 - March 25, 1977

ITINERARY:
Departed Honolulu: January 6, 1977
Arrive Papeete, Tahiti: February 2, 1977
Depart Papeete, Tahiti: February 8, 1977
Arrive Taiohae Bay, Nuku Hiva: February 11, 1977
Depart Taiohae Bay, Nuku Hiva: February 12, 1977
Arrive Taiohae Bay, Nuku Hiva: February 23, 1977
Depart Taiohae Bay, Nuku Hiva: February 24, 1977
Arrive Papeete, Tahiti: February 27, 1977
Depart Papeete, Tahiti: March 2, 1977
Arrive Honolulu: March 25, 1977

OBJECTIVES:

1. To investigate the distribution of offshore dolphin (porpoise) populations in the eastern tropical Pacific. The tracks of the *Cromwell*, as those of the *David Starr Jordan*, which also sailed during this period, were designed to complement and extend the coverage of the aerial survey.

2. To study and compare school structure and behavior in different portions of the dolphin ranges.

3. To investigate and photograph differences in dolphin color patterns within and between schools throughout the area traversed.

4. To study the trophic interactions involved in the dolphin-seabird-fish associations.

5. To collect and analyze physical oceanographic data for correlation with dolphin distribution.

6. To devise consistent, accurate techniques for estimating the distance to sighted schools.

7. To collect data concerning the distribution and biology of pelagic squids.

OPERATIONS:

During daylight hours, a watch was maintained from the wings of the ship's bridge (height of eye 21.5 feet) with 20X spotting binoculars. These observations were interspersed with scans of the nearby waters with the naked eye and hand-held binoculars. All sightings of birds, mammals, and tuna were recorded. Each observer recorded the sighting conditions hourly and also counted flying fish for a 5-minute period during his watch.

The watch periods were 2 hours in duration. Observers exchanged positions on the two bridge wings hourly.

The ship changed course to approach each dolphin school and most whales for identification, school size estimates, and photography. Once a school was sighted, all other research effort was halted until observation of that school was completed.

Within the survey area, the Cobb midwater trawl was deployed at selected stations. The trawl was deployed at 25 fathoms/minute until 125 fathoms of wire were out. It was retrieved in 25-fathom increments with 5-minute intervals between each increment. The catch was sorted, numbers and volumes were recorded, and specific organisms of interest were preserved for further study.

During the Cobb trawl operation, a 30-minute surface tow was made with a 1-meter plankton net. These samples were preserved for analyses by the Honolulu Laboratory.

Following the trawl operation, approximately 1 hour was spent jigging for squid. The samples taken were identified to species, measured, and ranked according to their sexual maturity. Unique specimens were preserved and returned to the laboratory.

Upon completion of the evening stations, the ship continued along the predetermined track at a speed such that no more than 220 miles/day were traversed.

RESULTS:

A total of 88 marine mammal sightings was recorded (Table 1). Thirty-six dolphin schools representing seven species were sighted (Figure 1). Three small schools were lost and remained unidentified. Of the 55 whale sightings, about half were identified to species. All identifications are tentative until the photographs and logs are reviewed. A brief discussion of each species sighted follows.

Stenella attenuata - (spotted dolphin)

Of the 10 schools of spotted dolphins sighted (Figure 2), four were associated with island groups (two Hawaiian, two Marquesan). The island schools showed little or no fear of the vessel and individuals from three of the schools rode our bow briefly. I questioned yacht sailors about porpoise sightings in the Tuamotus and Marquesas. Most of them mentioned "white-snouted porpoise" that rode their bows near specific islands in both groups. It seems likely that these were spotted dolphin.

The six schools sighted in open water were relatively small (four were comprised of 50 or less, largest 200 individuals). The school sighted at 9°13'N latitude, and 127°00'W longitude was estimated at 200 animals, but sighting conditions were so poor that we may have missed much of this school. Three of these schools were in the area of intense shallow thermocline between 8° and 12°N latitude, and two schools were near the area of upwelling along the equator. Three of the six schools carried flocks of from four to 100 birds (Figure 3). Tuna schools were not seen with any of these dolphins.

The behavior of the spotted dolphins was very similar to that seen last year from the *Cromwell*. As we approached these schools, the animals would only break the water with a small part of their dorsal surface. They caused very little visible water disturbance, and consequently were very difficult to follow. Spotted dolphin schools seemed more willing to make large changes in direction when approached by the vessel than do other species. They were repeatedly observed making large splashes when at a great distance from the vessel, but once we approached within 1 to 3/4 of a mile, they generally stayed low in the water.

Stenella longirostris - (spinner dolphin)

Four schools of spinner dolphin were sighted (Figure 2). Those in the northernmost school resembled the whitebelly spinners of the eastern Pacific. The external features of the other three schools were more like Hawaiian spinners.

The northernmost school (11°16'N latitude, 147°25'W longitude) carried a small flock of *Pterodroma* petrels with it. The school was estimated at 250 animals but the sighting conditions were poor and many animals could have been missed. Some individuals in this school of whitebelly spinners were noted to have a distinct dark band between the lateral and ventral fields. This school was very casual about our approach and some parts of the school moved towards us rather than away.

The two schools sighted in open water south of the equator closely resembled the Hawaiian form of spinner. Most had a distinct dorsal cape, a light grey lateral field, and a white ventral field that extended dorsad nearly to eye level. The dorsal fins were mostly falcate but some males displayed triangular fins and small ventral keels. There was much variability in color pattern noted within these schools. On some individuals, the three-phase color pattern was less distinct and they looked like whitebelly spinners. The majority of the animals however, resembled the Hawaiian form. In both schools, many individuals had a distinct dark band separating the lateral and ventral fields. These schools showed little fear of the ship, and we were able to approach within 100 yards before they moved away from us. Head slaps were seen three times in the school sighted near 9°S, and a few high spins were seen while following the school near 4°S.

As we passed the island of Nuku Hiva (Marquesas), a small group of spinners approached the ship and two individuals rode the bow wave until they were replaced by two *Tursiops*. These spinners had the crisp contrasting features of Hawaiian spinners: black snout tip, dark flippers, and a distinct three-phase color pattern.

Stenella coeruleoalba (streaker or striped dolphin)

Five striped dolphin schools were sighted (Figure 4). Two schools were along the thermocline ridge between 8-11°N, and the other three were near the region of upwelling along the equator. None of these schools was associated with bird flocks. They all actively avoided the ship. One school of 60 animals submerged as we approached and, after staying under water for 30-40 seconds, reappeared on a heading perpendicular to its original course. Animals from two of the schools were observed jumping high out of the water and crashing down on their sides or backs.

Delphinus delphis (common or whitebelly dolphin)

One school of common dolphin was sighted at 12°N, 133°W (Figure 4). This is near the location of a sighting by the *Jordan* last year. The animals were mostly dark gray with cream-colored bellies and strongly falcate dorsal fins. The lateral hourglass pattern was not seen. This school was sighted near approximately 100 White-necked Petrels. These birds were feeding actively but sea conditions were too rough to tell if there were any tuna under them.

Lagenodelphis hosei (Fraser's dolphin)

Three schools of Fraser's dolphin were sighted (Figure 5). These schools were all near to the equator. The animals were medium gray on the dorsal surface, cream-white to pink on their ventral surface, and most had a wide, black stripe running from the eye to the anus. The visibility of the stripe varied considerably within the school. It was noticeably faint on some full-sized animals and absent on most neonates. The brightest pink bellies were seen on younger (smaller) animals. The animals were chunky and had small pectoral fins and short rostrums. The size of the dorsal fin varied within each school from being noticeably small to being spotted dolphin-sized.

The appearance of a *Lagenodelphis* school when approached, is very dramatic and unique. The school contracts in size as the ship gets closer, until the animals are packed tightly together. When the ship closes to about 100 yards, the school suddenly explodes from the water and sprints off in a mass of bodies and white water.

Feresa/Peponocephala (pygmy killer whale/melon-headed whale)

Seven schools of *Feresa* sp. or *Peponocephala* sp. were sighted (Figure 5), but even after examination of the photographs we could not tell if they were *Feresa* or *Peponocephala* sp. The schools ranged in size from 10 to 450 individuals. The animals were dark-gray to brown in color, 7-9 feet long. Some individuals had a white patch on the chin or around the anus. The dorsal fins were relatively large and falcate. This character varied considerably between individuals in the same school (sexual dimorphism?). The swimming behavior of these animals made it very difficult to see them well. Even when swimming rapidly they barely broke the surface. Their blunt heads pushed a splash of water ahead and to each side as they surfaced. Often this splash and the tip of the dorsal fin were all that an observer would see. They changed their direction underwater very frequently. The schools split easily when followed, but if a small fraction was pursued, it would generally lead the ship back to the main body of the school. The schools did not run from the vessel until it was about 0.5 nautical miles from them, and if we slowed to 4-5 knots we could get within 1/4 nautical mile before they would start moving away from us. While we were turning sharply to follow one small school, the animals doubled back on us and came upon our wake. The school stopped at the edge of our wake and milled around for a few seconds. Then they all submerged and were not seen again.

Steno bredanensis (rough-toothed dolphin)

One small school of *Steno* was seen around 9°S (Figure 5). These animals are very difficult to spot if there is any sea running because they don't rush or splash in reaction to the vessel's approach. They seemed almost totally to ignore us. They were observed swimming slowly in small groups or rafting at the surface.

Tursiops truncatus (bottlenosed dolphin)

Tursiops were seen twice near the Marquesas and three times in the Hawaiian Islands. All the schools rode the bow briefly except the last school, near Maui. These animals were swimming very closely to two hump-back whales.

Globicephala macrorhynchus (pilot whale)

Pilot whales were sighted near the Hawaiian, Marquesas, and Tuamotu Islands (Figure 6). A fourth group was seen about 500 nautical miles east of Hawaii. The groups were all small, 5-13 animals, and were not associated with birds or signs of fish schools. Two pods were accompanied by small schools of *Tursiops*.

Pseudorca crassidens (false killer whale)

False killer whales were sighted five times during the cruise (Figure 6). These animals appeared unafraid of the ship. One group rode the bow for about 20 minutes after the ship was slowed to 6-7 knots using only one engine. Another pod rushed towards us but they did not bow-ride. The group around 5°N was associated with a small flock of Tahiti/Phoenix petrels.

Orcinus orca (killer whale)

A pod consisting of seven individuals of this large delphinid was sighted (Figure 6). While we were near them their respiration pattern consisted of a series of three blows spaced 20 seconds apart followed by a 2-2.5 minute dive.

Mesoplodon sp. (beaked whale)

Beaked whales were sighted on four occasions (Figure 7). They were generally brown in color and had thick, slightly back-curved dorsal fins. When they broke the surface to breathe, they normally exposed most of the rostrum and melon. These animals cause very little disturbance in the water and are consequently very difficult to see. They were in pods of 2-8 individuals. One group spent 4-5 minutes near the surface and then made a 6-8 minute dive.

Physeter catodon (sperm whale)

Sperm whales were sighted seven times during the cruise (Figure 7). With the exceptions of the two sightings near the Hawaiian and Tuamotu Islands, all the pods were near the thermocline ridge at approximately 10°N or near the equator. Two of the sightings near 11°N were of single animals while the others were of groups of 4-12 animals.

Balaenoptera (baleen whales)

The seven sightings of fin, sei, and Bryde's whales were mostly clustered near the equator (Figure 8). All were sighted singly or with one other animal of the same species. Most of the whales made no noticeable effort to avoid the vessel. We were able to observe them closely for positive identification and to time respiration and dive intervals.

Megaptera novaeangliae (humpback whale)

A total of 40 individuals of this species was sighted in a 2-day period near the Hawaiian Islands (Figure 9). Most animals were seen singly; however, groups of as many as five animals were sighted. The whales were not afraid of the vessel. Full-body breaches, lobtailing, and flipper slapping were observed repeatedly. On one occasion, two whales were seen within a school of skipjack tuna.

Physical Oceanography

A total of 243 XBTs was launched at about 50-mile intervals during the cruise (Figure 11). The ship's thermosalinograph was checked and annotated regularly. Daily surface water samples were taken as a check on the salinity record from the ship's system. Analyses of these samples revealed a consistent error of +0.2 ppt after our first stop in Tahiti.

Figure 12 presents a generalized plot of the XBTs taken, the surface temperature, the surface salinity, and the sightings of spotted, spinner, and striped dolphins. The Tropical Surface Water mass begins around 13°N as the thermocline becomes more intense and the water warms to 25°C. The thermocline rises to about 30 m below the surface between the North Equatorial Current and Countercurrent (the "ridge" near 10°N). It then drops abruptly and weakens. At about 2°N the salinity increased and the temperature dropped as we entered the Subtropical Water mass. The dolphin sightings are clustered along the shallow thermocline of the "ridge" and along the upwelling system of the equator.

Due to the El Niño condition that existed last year continuing into this year, the surface water temperature along the equator was 2°-3°C warmer than it was when the *Cromwell* passed through in January 1976.

Night Stations

Thirty-one Cobb trawls, 30 squid-jig stations, and 30 plankton tows were accomplished during the cruise (Figure 11). Rough analyses of trawl and squid station data revealed that the largest biomass of fish and squid were caught near the 10°N thermocline ridge. There was another peak in combined biomass near the equator. When comparing the squid versus fish catch on a station-by-station basis, an interesting fact was noted. From 8-12°N, there was an inverse relationship between the number of squid hooked on the jigs and the volume of fish caught in the trawl (Figure 13). This relationship was noted on both legs I and III of the cruise. One must be very cautious about drawing conclusions from these data, since the vulnerability of squid to jigs seems to be highly variable.

Bird Observations

Thirty-seven species of seabirds were identified during the cruise. Those species which were seen associated with mammal schools at least once were: wedge-tailed shearwater (*Puffinus pacificus*), Newell's shearwater (*P. puffinus newelli*), white-necked petrel (*Pterodroma externa*), Tahiti petrel (*P. rostrata*), Leach's storm-petrel (*Oceanodroma leucorhoa*), tropicbird (*Phaethon* sp.), and sooty tern (*Sterna fuscata*) (Figure 3). Almost all the birds associated with dolphin schools were either sooty terns or white-necked petrels.

The greatest abundance of sooty terns (see Figure 14) was found in pelagic areas between 1°N and 14°S. Observations were made in this area on 21 days; on all but two of these at least 300 individual sooty terns were seen, and numbers per day ranged up to 2000. None of the flocks in this area was associated with dolphins, however. North of 1°N, sooty terns were scattered. Occasional large flocks or local concentrations would be seen, but most days would produce less than 100 individuals, and sometimes none at all.

A conspicuous exception to this generalization was encountered from March 15-20, between 9°30'N and 12°30'N, 139°W and 132°W. Sooty tern abundance in this area varied between 110 and 530 per day. Away from the immediate vicinity of the Hawaiian Islands, sooty terns were virtually absent north of 15°N.

White-necked petrels (see Figure 15), of which almost all were of the nominate race *Pterodroma e. externa* ("Juan Fernandez Petrel"), in marked contrast to sooty terns, were found almost exclusively north of 1°N. Only four individuals were encountered south of this line. The greatest concentrations were found between 1°N and 13°N. Particularly large numbers (19-92 per day) were found in the same area as the concentrations of sooty terns, March 15-20. The area from 1°N to 13°N was also an area of greater abundance for some of the other procellariid species: wedge-tailed shearwater, Newell's shearwater, and Tahiti petrel (north to 7°30'N only).

The most widespread species encountered on the cruise was Leach's storm-petrel, which was seen every day the ship was out of sight of land. Apparent association of this species with mammals was probably either coincidental or related only through the greater productivity of the particular area. Local concentrations could be found almost anywhere in the area covered by the cruise, but a tendency to greater abundance was noticed north of the equator east of 132°W.

Of the other species which were seen in large numbers, most were concentrated within 400 miles of the islands of French Polynesia. These included white tern (*Gygis alba*), brown noddy (*Anous stolidus*), black noddy (*Anous tenuirostris*), and red-footed booby (*Sula sula*). Although large flocks of these would often be seen over schools of fish, none was seen over dolphin schools.

COMMENTS AND RECOMMENDATIONS: This year's cruise track crossed a section of the area along the equator that was investigated during the 1976 Boundary Cruise (*T. Cromwell* Cruise No. 76-01-68). During the 1976 cruise we saw few bird flocks and no dolphin at all in or near this common region. In the same area this year we found many more birds and saw one-to-three schools of dolphins per day. This apparent shift in dolphin populations was also noted by the scientific party aboard the *Jordan* (*D.S. Jordan* Cruise No. 77-01-107).

This year there was an El Niño condition in effect causing a 2°-3°C warming of the surface water along the equator. It appears that this warming may have resulted in a westward shift in eastern Pacific dolphin poise populations. The effects of changes in oceanic conditions (seasonal or irregular) upon dolphin distributions is poorly understood and certainly merits further investigation.

We found that in this area of the Central Pacific, bird flocks were only associated with dolphins within the boundaries of the tropical water mass (about 2-14°N). Although many schools were sighted in the subtropical waters to the south, none carried birds.

Tuna schools were not seen with dolphins at any time during the cruise. School fish (mostly skipjack) were frequently sighted under flocks of terns near the Marquesas and Tuamotus. The farther south that we travelled, the larger the percentage of white terns (instead of sooties) sighted over these schools.

A dominant factor that affected the entire cruise was the almost constant bad weather. North of the equator the sea state was generally 4-6 on the Beaufort scale. Heading into these seas, we had to cover one or both of the 20X binoculars, and often both observers would be restricted to the lee side of the bridge. During the final 3-week leg the weather was terrible. Toward the end of the leg, I altered the track so that we could beat into the seas at night and then run down-swell while we were observing. The *Cromwell* is much too small to be an effective sighting platform in the windy central Pacific.

On the final day of the cruise, an attempt was made to test the *Cromwell*'s sonar system as a tool for porpoise research. The system would not function in the active mode. In the passive mode, we located a school of spotted dolphin from their clicks and squeals at a range of about 0.5 nautical miles. If the *Cromwell* is to be used again for porpoise research, the potential of this sonar system for locating porpoise schools should be investigated.

As they were last year, the officers and crew of the *Cromwell* were more than willing to provide any assistance necessary to make our cruise more effective.

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Date June 29, 1977 Prepared by Wayne L Perryman
Wayne Perryman
Chief Scientist

Date 7/1/77 Approved by Izadore Barrett
Izadore Barrett
Center Director

Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)

Table 1. Mammal Sightings

Date	Position	Mammal	School/Pod Size
7 Jan	20°42'N/154°06'W	*Physeter catodon*	7
7 Jan	20°12'N/149°50'W	*Balaenoptera* sp.	1
9 Jan	19°00'N/146°28'W	*Globicephala macrorhynchus*	5
10 Jan	18°51'N/142°14'W	*Pseudorca crassidens*	8
15 Jan	12°07'N/132°55'W	*Delphinus delphis*	500
15 Jan	11°48'N/132°10'W	*Physeter catodon*	1
16 Jan	10°40'N/127°48'W	Unid. large whale	2
18 Jan	09°19'N/126°21'W	*Stenella coeruleoalba*	60
18 Jan	09°13'N/127°00'W	*Stenella attenuata*	200
19 Jan	08°36'N/131°10'W	*Stenella attenuata*	35
20 Jan	08°20'N/132°51'W	*Stenella coeruleoalba*	5
20 Jan	08°18'N/133°02'W	*Physeter catodon*	12
20 Jan	08°06'N/134°32'W	Unid. large whale	2
20 Jan	08°05'N/134°42'W	Unid. large whale	1
20 Jan	08°05'N/134°50'W	Unid. large whale	2
22 Jan	06°53'N/131°44'W	Unid. small whale	1
23 Jan	05°49'N/128°00'W	*Pseudorca crassidens*	3
23 Jan	05°46'N/127°54'W	Unid. large whale	1
24 Jan	03°21'N/129°20'W	*Feresa/Peponocephala*	80
24 Jan	03°32'N/129°48'W	*Stenella attenuata*	100
26 Jan	02°47'N/134°13'W	Unid. medium-sized whale	2
26 Jan	02°30'N/134°29'W	*Orcinus orca*	4
26 Jan	01°40'N/135°08'W	Unid. small whale	5
27 Jan	00°16'N/136°10'W	*Balaenoptera borealis*	2
27 Jan	00°02'S/136°25'W	*Balaenoptera borealis*	1
27 Jan	00°37'S/136°52'W	*Lagenodelphis hosei*	2000
28 Jan	03°23'S/138°53'W	*Pseudorca crassidens*	2
28 Jan	03°56'S/139°18'W	*Balaenoptera borealis*	2

Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)

Table 1. (Continued)

Date	Position	Mammal	School/Pod Size
29 Jan	05°42'S/140°36'W	Unid. small whale	2
29 Jan	07°05'S/141°38'W	Unid. large whale	2
30 Jan	09°05'S/143°08'W	Stenella longirostris	50
30 Jan	09°33'S/143°25'W	Unid. blackfish	4
30 Jan	09°38'S/143°27'W	Steno bredanensis	12
30 Jan	09°53'S/143°41'W	Unid. porpoise	9
31 Jan	13°14'S/146°14'W	Unid. medium-sized whale	1
31 Jan	13°31'S/146°28'W	Unid. porpoise	6
1 Feb	14°52'S/148°08'W	Physeter catodon	7
9 Feb	15°20'S/147°06'W	Feresa/Peponocephala	450
9 Feb	14°52'S/146°48'W	Unid. small porpoise	1
10 Feb	11°27'S/143°05'W	Mesoplodon sp.	8
11 Feb	09°04'S/140°15'W	Unid. small whale	2
14 Feb	04°24'S/136°23'W	Unid. small whale	1
15 Feb	02°44'S/135°06'W	Physeter catadon	8
15 Feb	02°38'S/134°52'W	Stenella coeruleoalba	3
15 Feb	02°33'S/135°02'W	Unid. large whale	3
15 Feb	02°32'S/134°57'W	Mesoplodon sp.	5
16 Feb	00°48'S/132°48'W	Physeter catadon	4
16 Feb	00°25'S/132°22'W	Unid. whale	1
16 Feb	00°10'N/131°50'W	Stenella coeruleoalba	125
16 Feb	00°12'N/131°48'W	Balaenoptera physalus	1
16 Feb	00°15'N/131°47'W	Feresa/Peponocephala	10
17 Feb	02°58'N/129°28'W	Lagenodelphis hosei	400
18 Feb	02°29'N/127°13'W	Unid. large whale	1
18 Feb	02°18'N/126°45'W	Feresa/Peponocephala	30
19 Feb	01°38'N/127°02'W	Lagenodelphis hosei	100
19 Feb	01°20'N/127°22'W	Pseudorca crassidens	30

Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)

Table 1. (Continued)

Date	Position	Mammal	School/Pod Size
20 Feb	01°09'S/129°48'W	Stenella coeruleoalba	40
20 Feb	01°26'S/130°10'W	Stenella attenuata	50
20 Feb	01°41'S/130°27'W	Mesoplodon sp.	4
20 Feb	01°43'S/130°29'W	Unid. small whale	1
20 Feb	02°10'S/131°00'W	Stenella attenuata	25
21 Feb	03°52'S/133°02'W	Stenella longirostris	70
22 Feb	05°29'S/135°22'W	Balaenoptera edeni	1
22 Feb	06°19'S/135°51'W	Feresa/Peponocephala	150
22 Feb	06°37'S/136°35'W	Unid. large whale	4
23 Feb	08°57'S/138°55'W	Stenella attenuata	30
23 Feb	09°00'S/139°40'W	Globicephala macrorhynchus + Tursiops truncatus	16
23 Feb	08°58'S/140°03'W	Stenella longirostris + Stenella attenuata + Tursiops truncatus	22
25 Feb	13°10'S/143°47'W	Unid. large whale	5
25 Feb	13°12'S/143°49'W	Unid. large whale	1
26 Feb	14°44'S/146°07'W	Unid. blackfish	3
26 Feb	15°39'S/147°30'W	Feresa/Peponocephala	60
26 Feb	15°41'S/147°28'W	Globicephala macrorhynchus	5
4 Mar	11°51'S/146°07'W	Unid. small whale	1
8 Mar	01°39'N/139°33'W	Balaenoptera edeni/borealis	2
16 Mar	10°15'N/143°00'W	Stenella attenuata	20
17 Mar	10°58'N/144!32'W	Physeter catodon	1
18 Mar	11°16'N/147°25'W	Stenella longirostris	250
23 Mar	19°22'N/155°56'W	Globicephala macrorhynchus	13

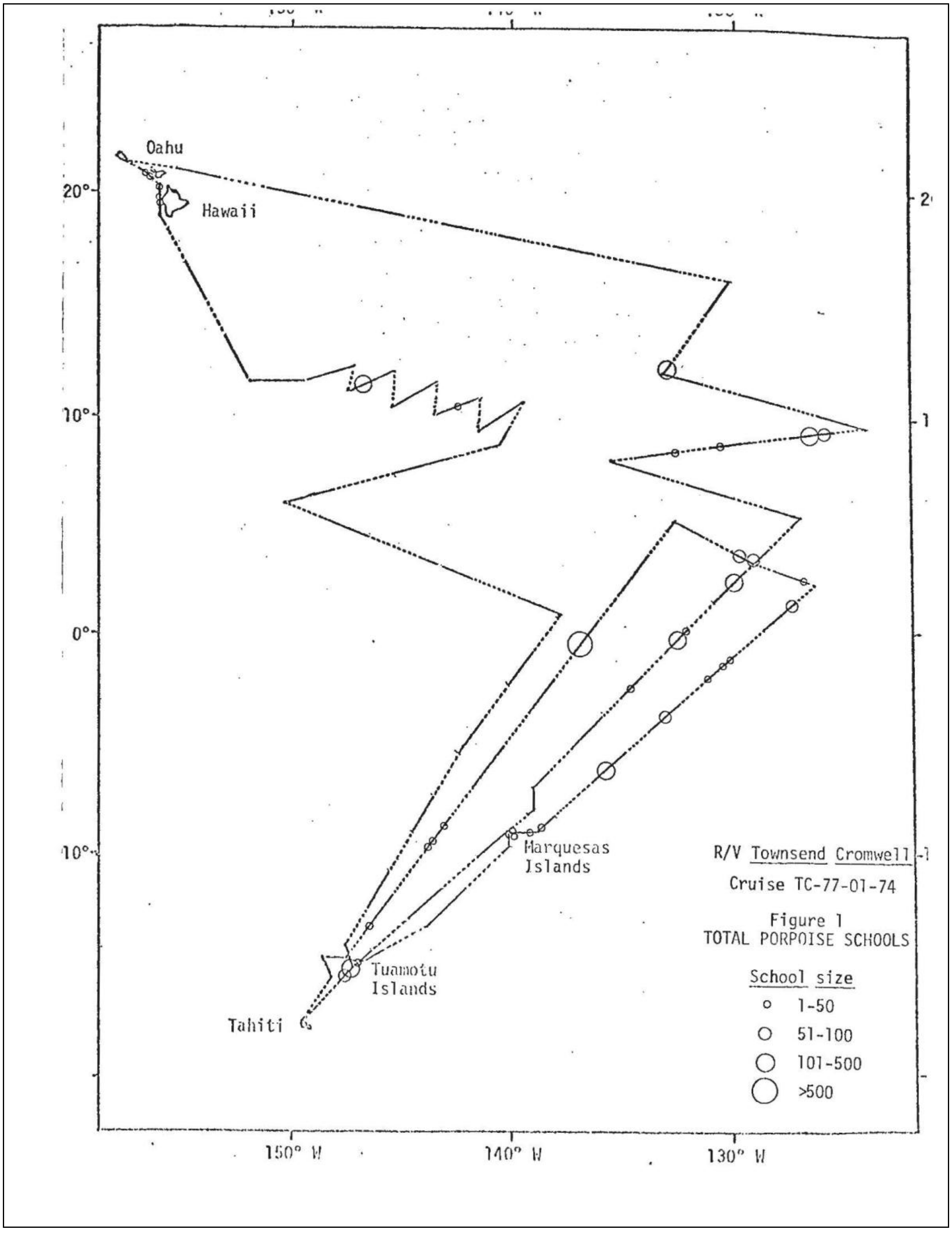
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)

Table 1. (Continued)

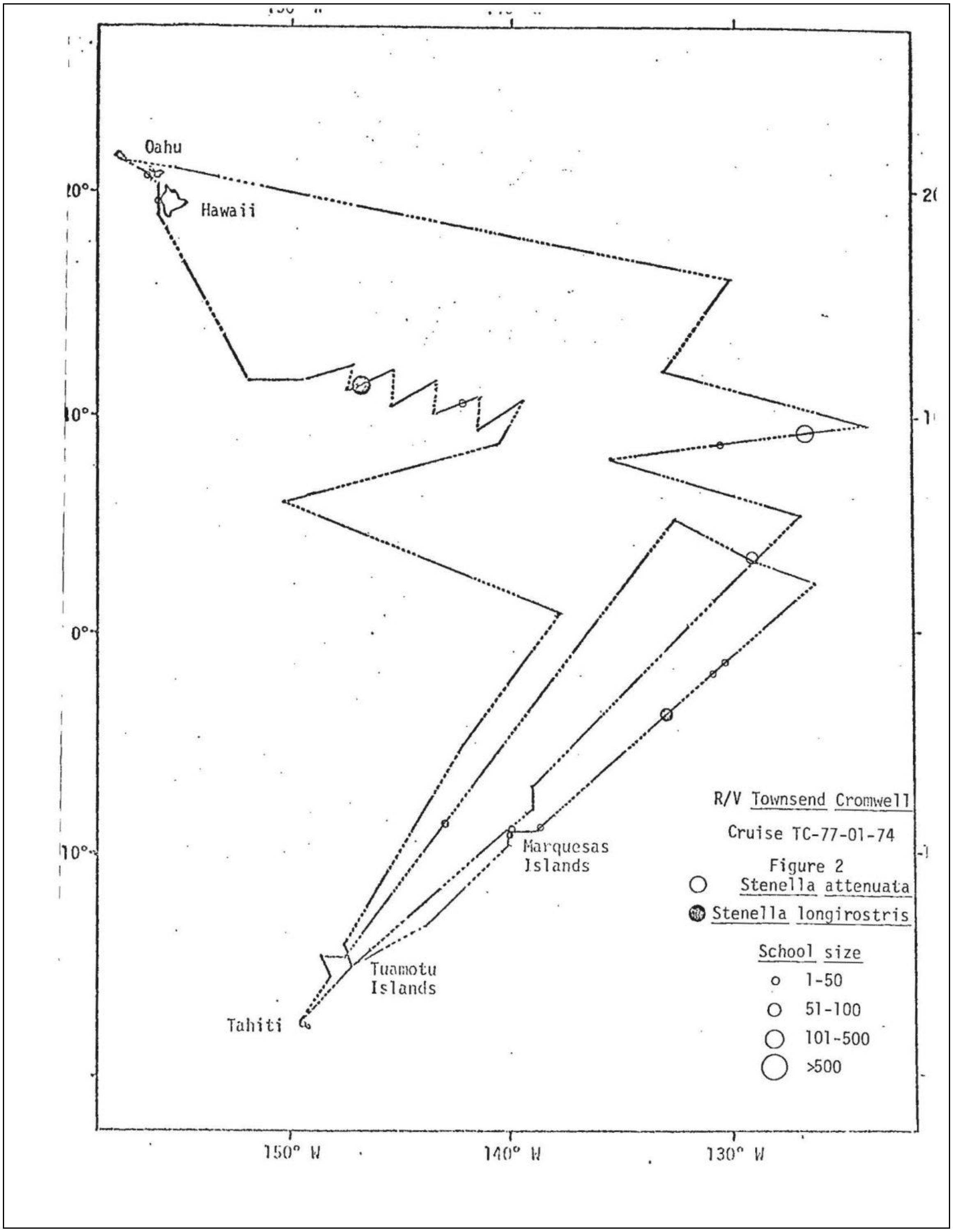
Date	Position	Mammal	School/Pod Size
23 Mar	19°40'N/156°04'W	Mesoplodon sp.	2
23 Mar	19°50'N/156°05'W	Tursiops truncatus	25
23 Mar	19°51'N/156°05'W	Megaptera novaeangliae	2
23 Mar	19°51'N/156°03'W	Stenella attenuata	35
23 Mar	20°01'N/155°52'W	Megaptera novaeangliae	1
23 Mar	20°03'N/155°53'W	Megaptera novaeangliae	2
		+	
		Feresa attenuata	8
24 Mar	20°26'N/156°45'W	Stenella attenuata	35
		+	
		Tursiops truncatus	1
24 Mar	21°04'N/157°13'W	Pseudorca crassidens	4
24 Mar	(*)	Megaptera novaeangliae	38
		+	
		Tursiops truncatus	7

* Sightings along channel between Maui, Lanai, and Molokai, of the Hawaiian Islands

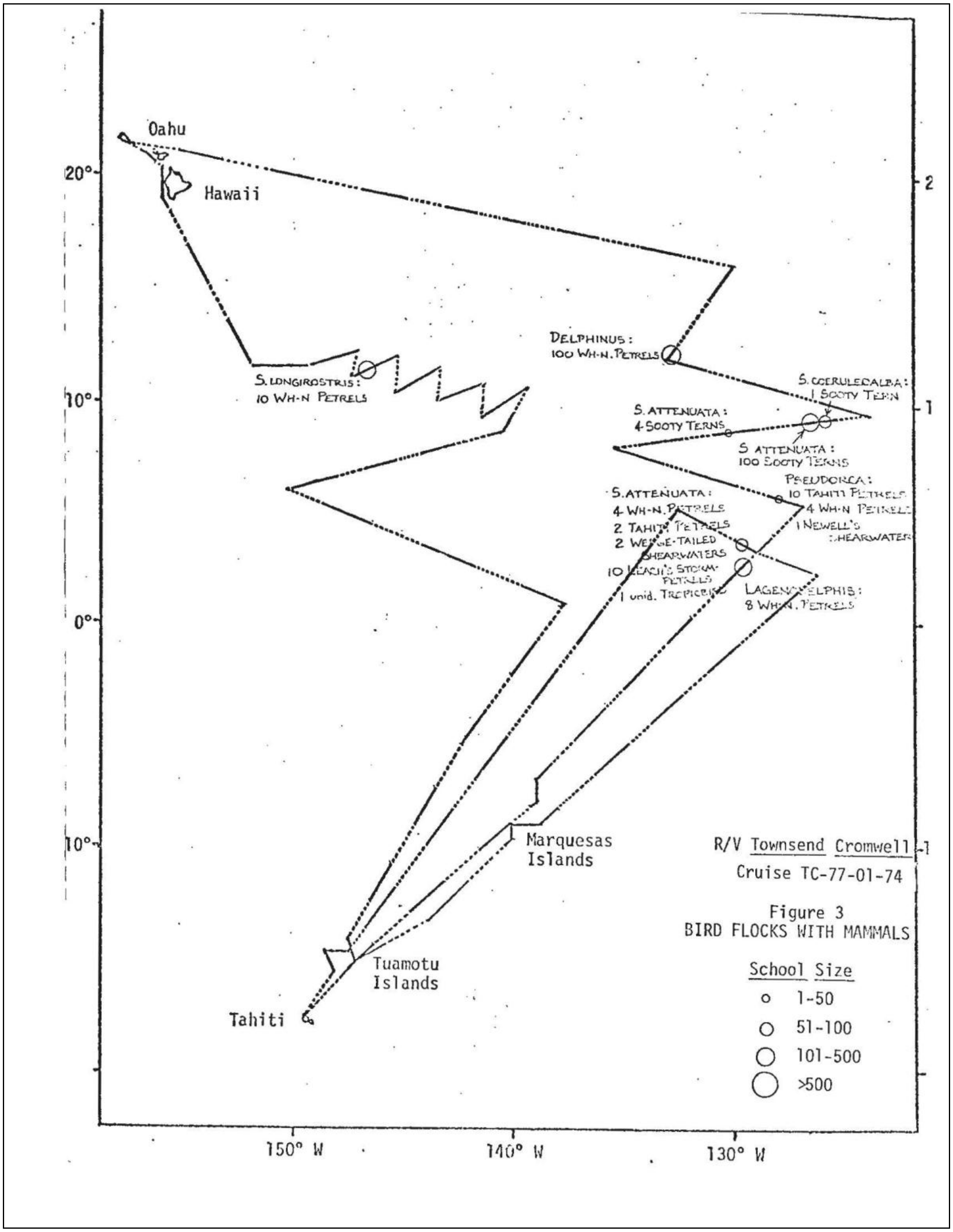
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



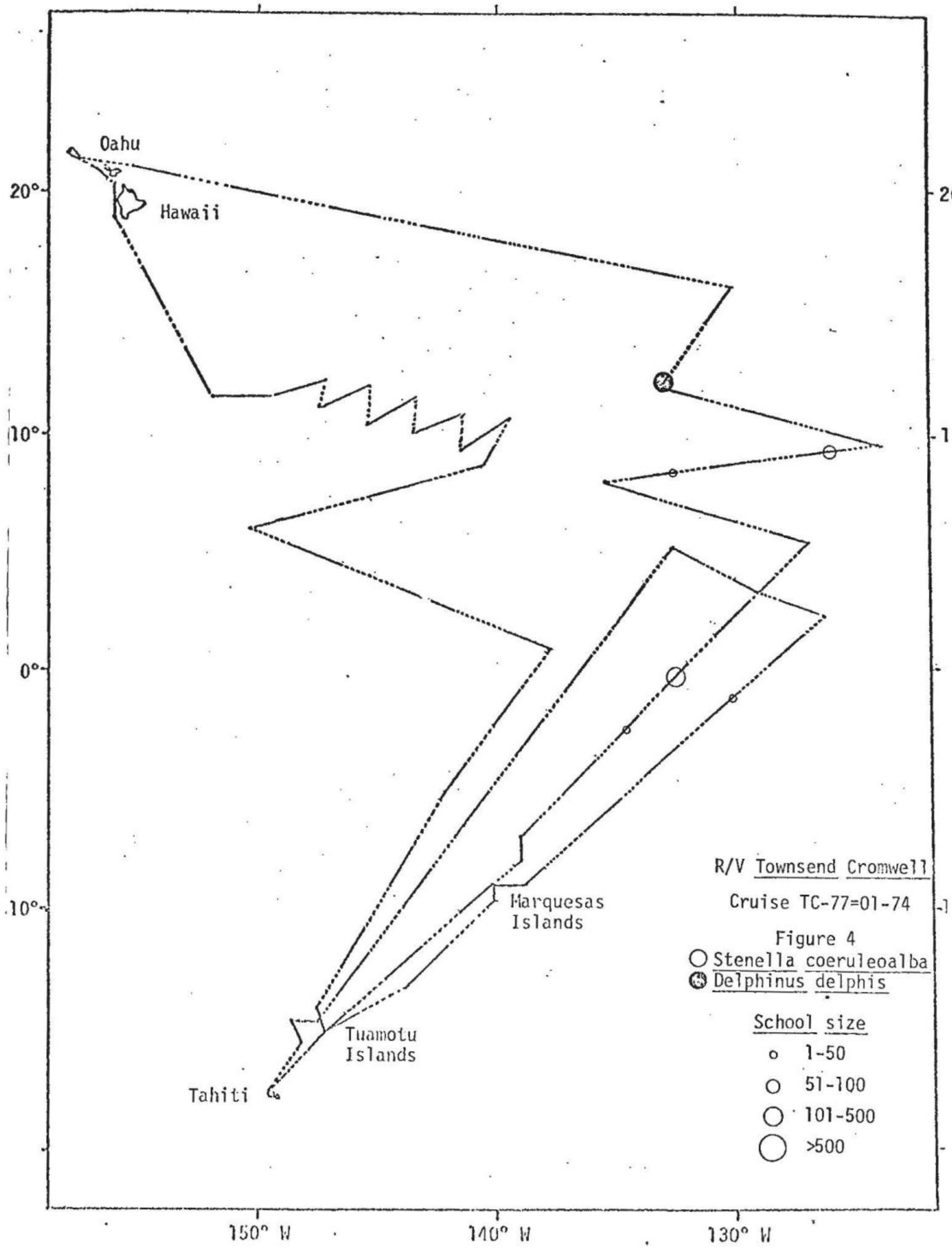
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



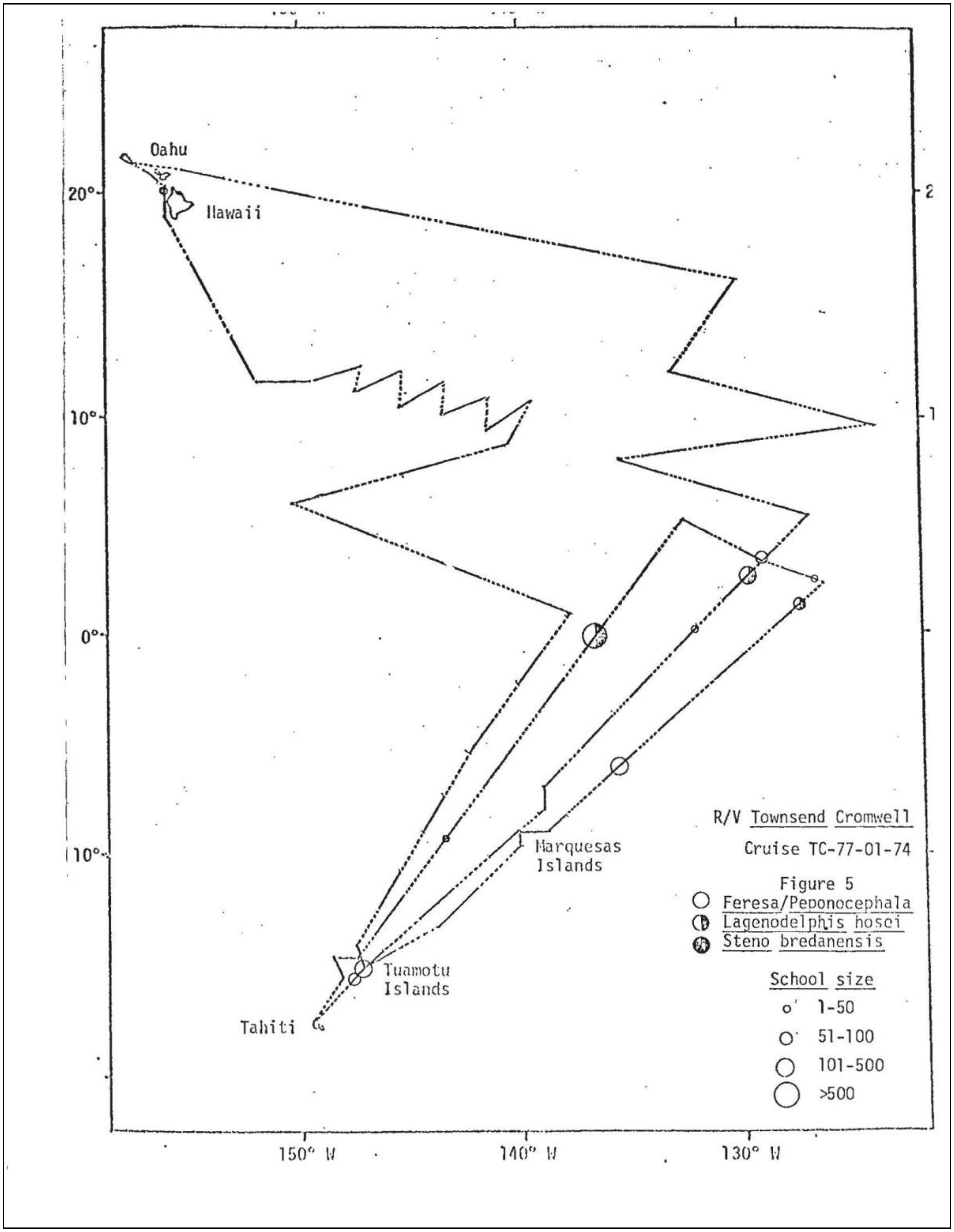
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



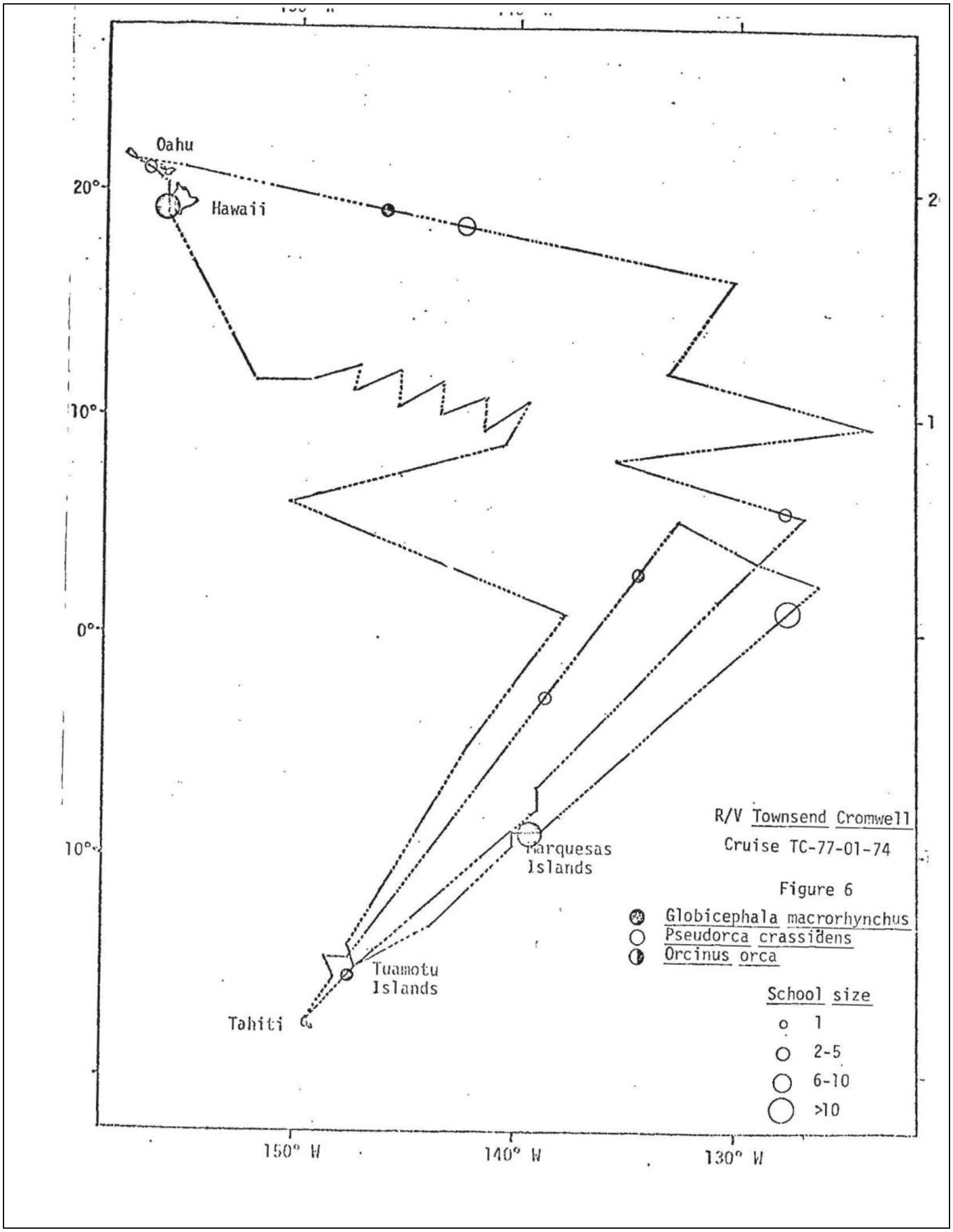
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



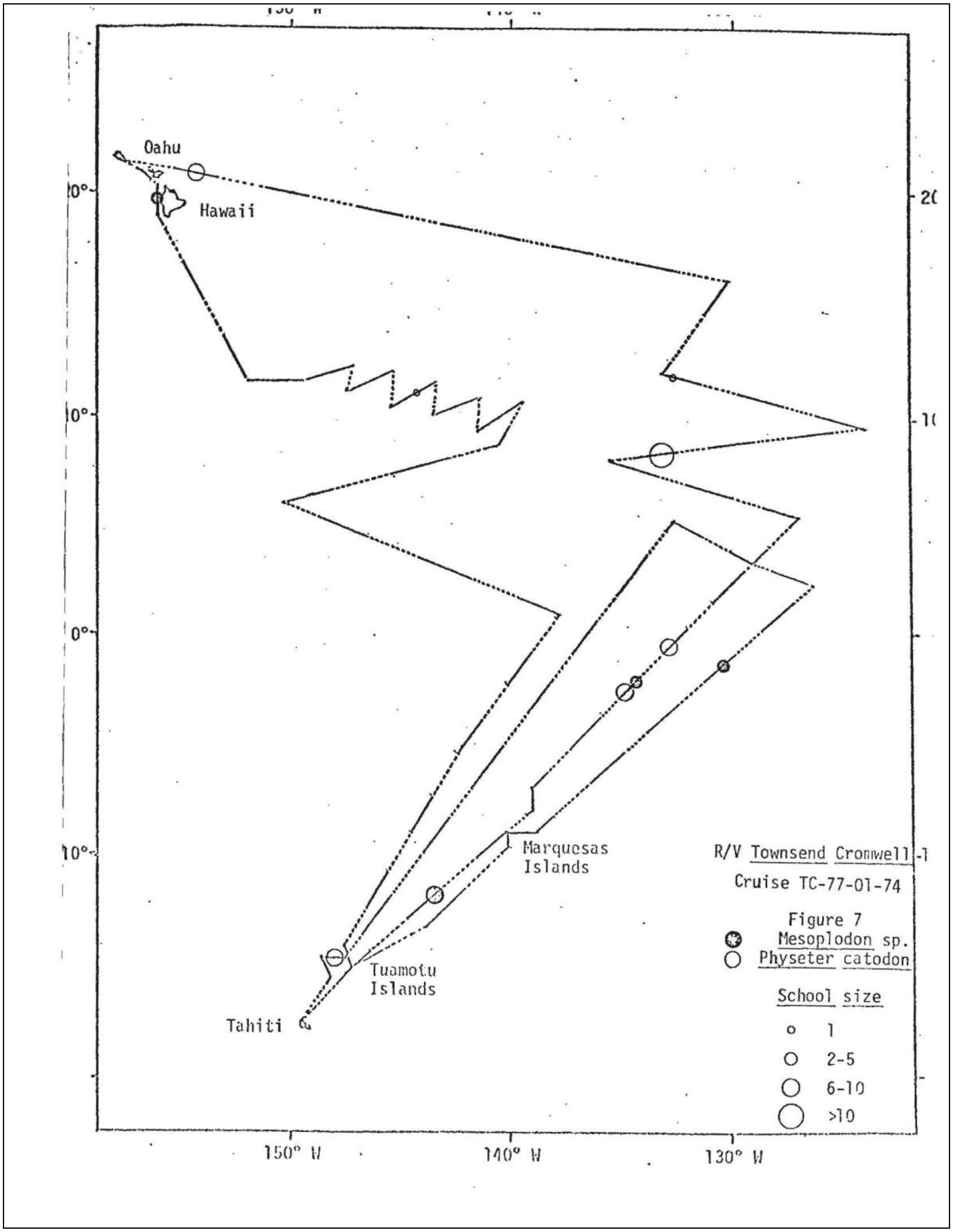
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



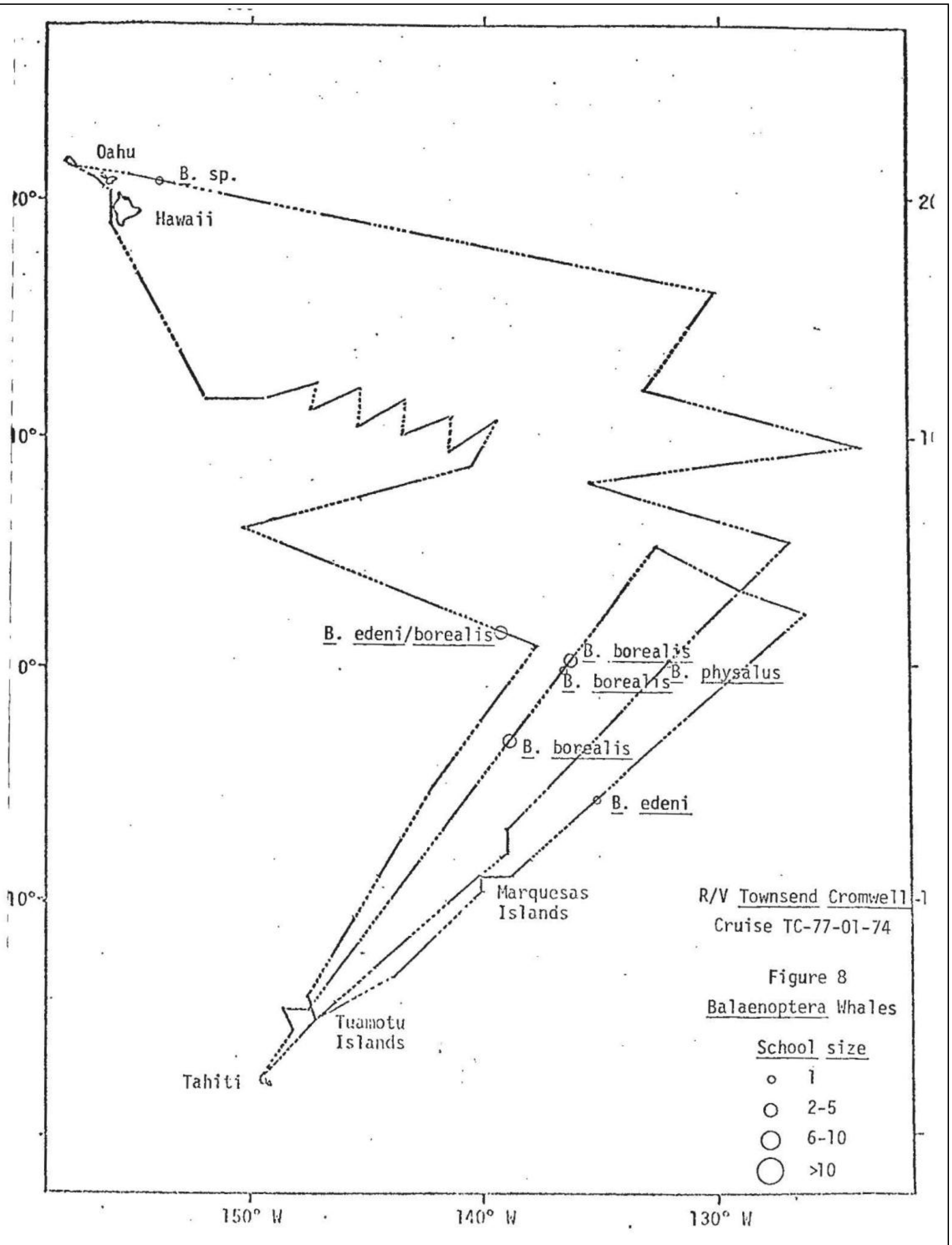
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



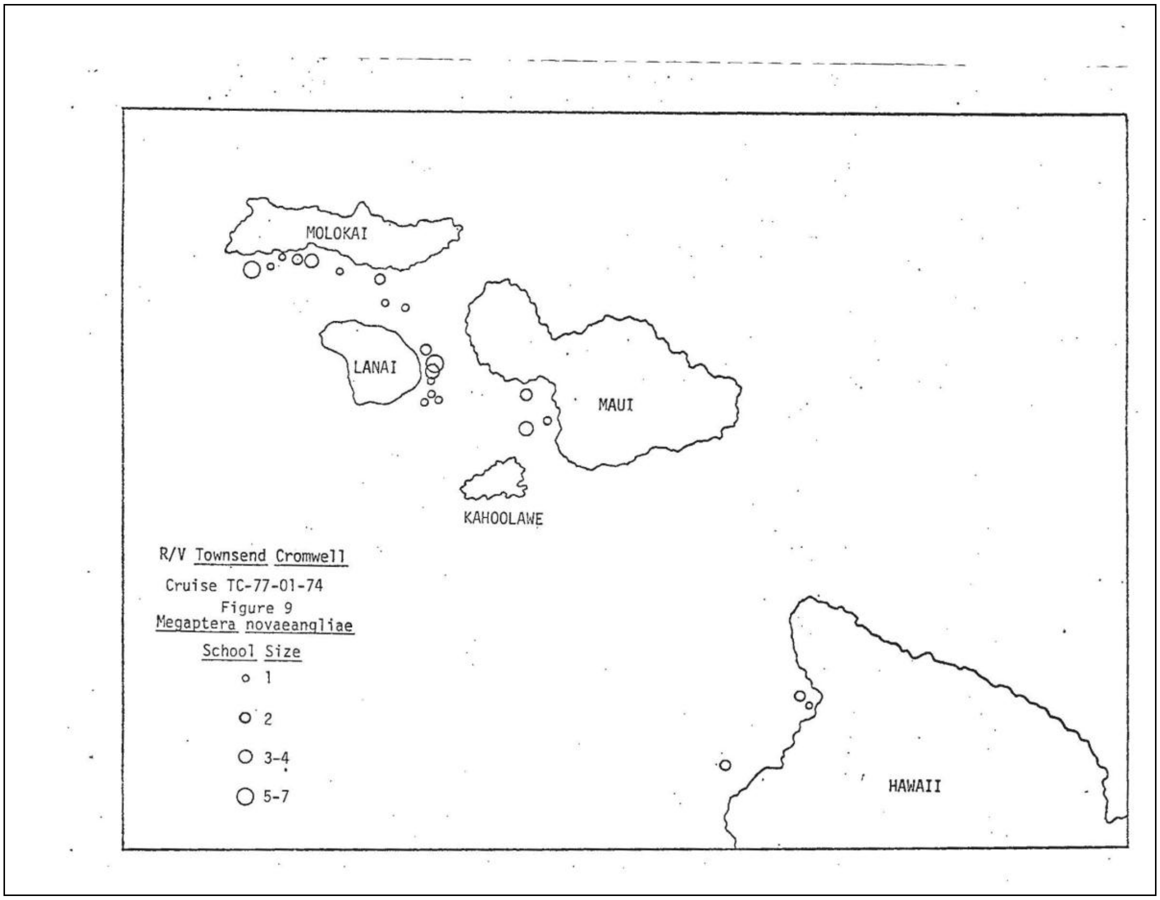
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



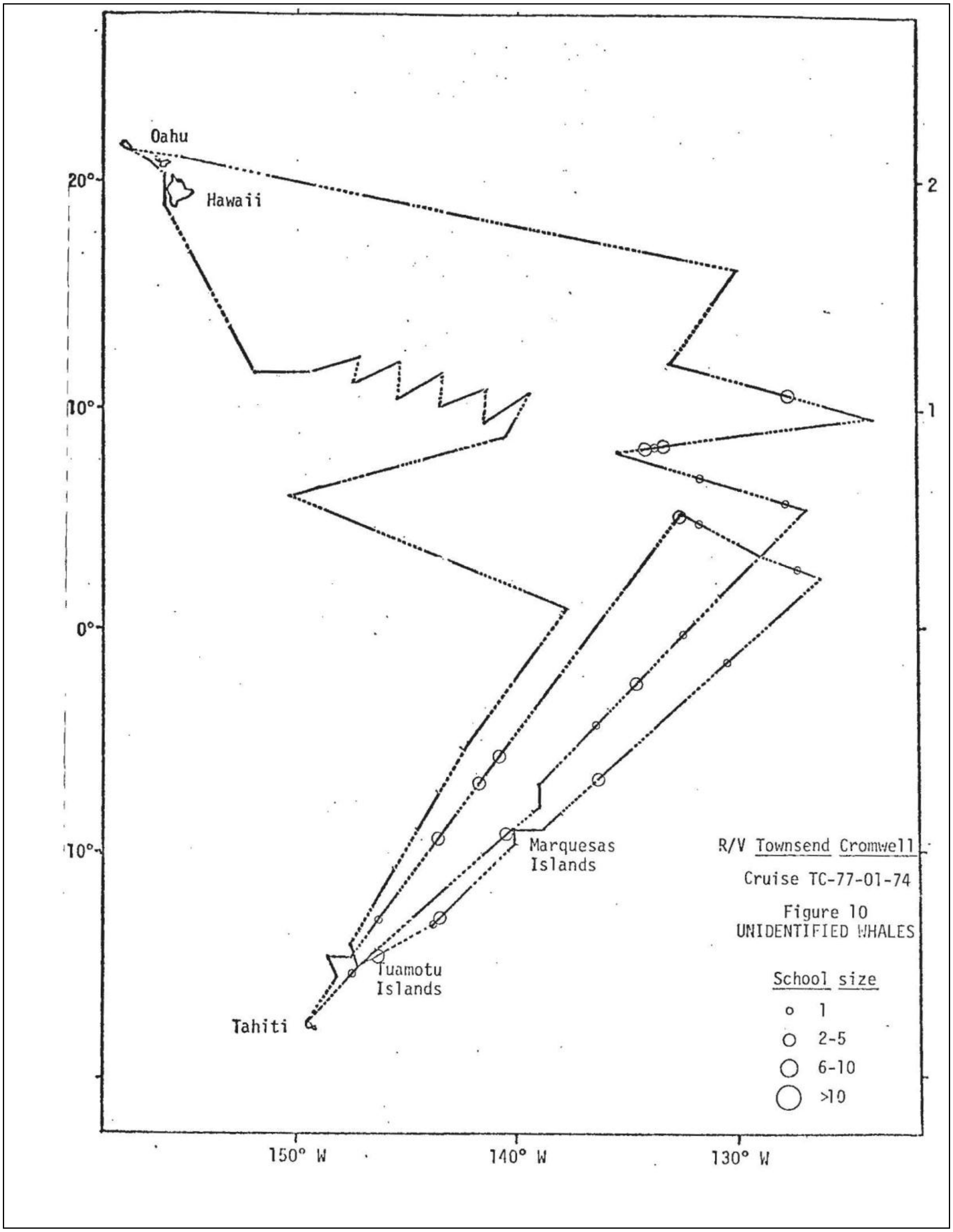
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



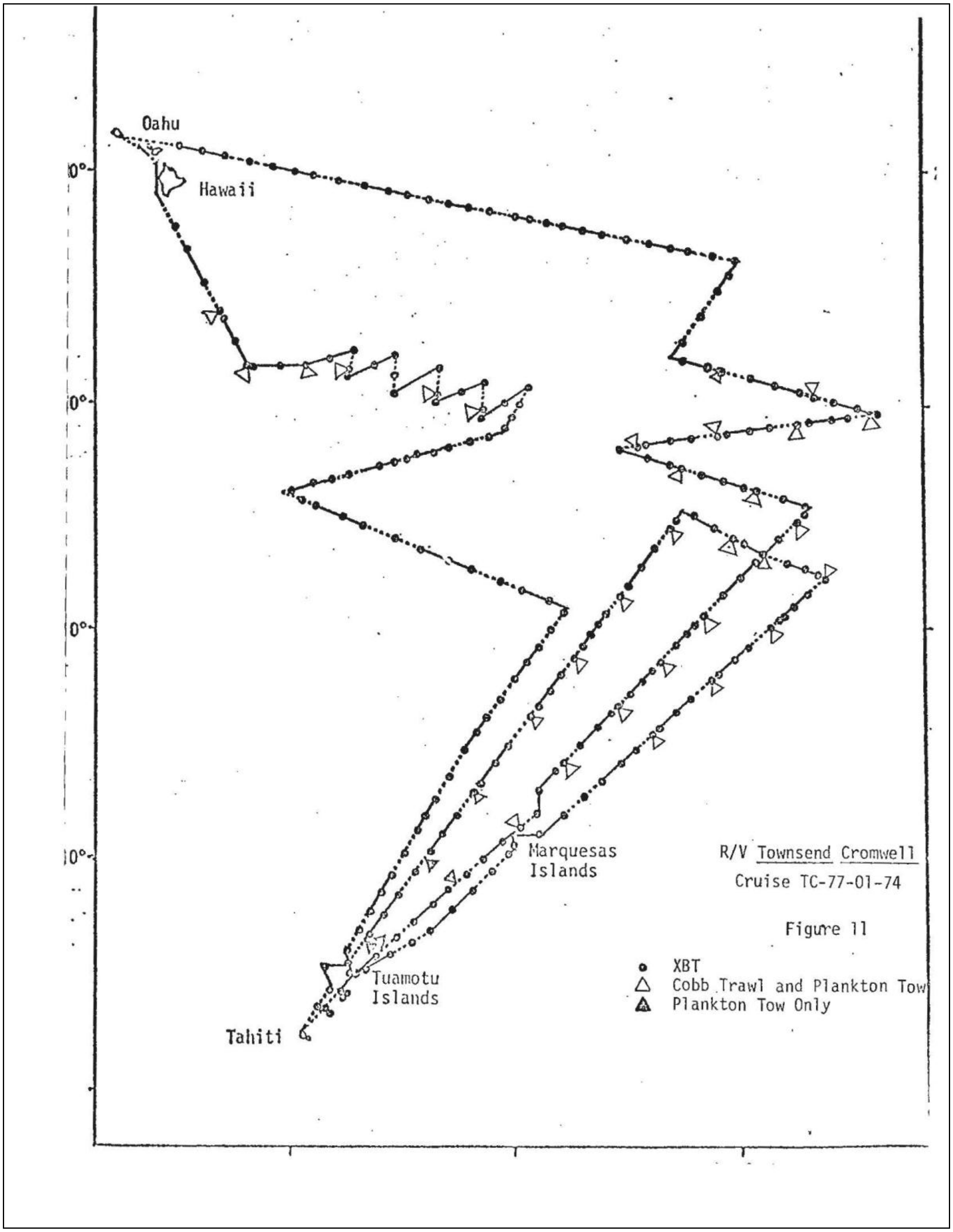
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



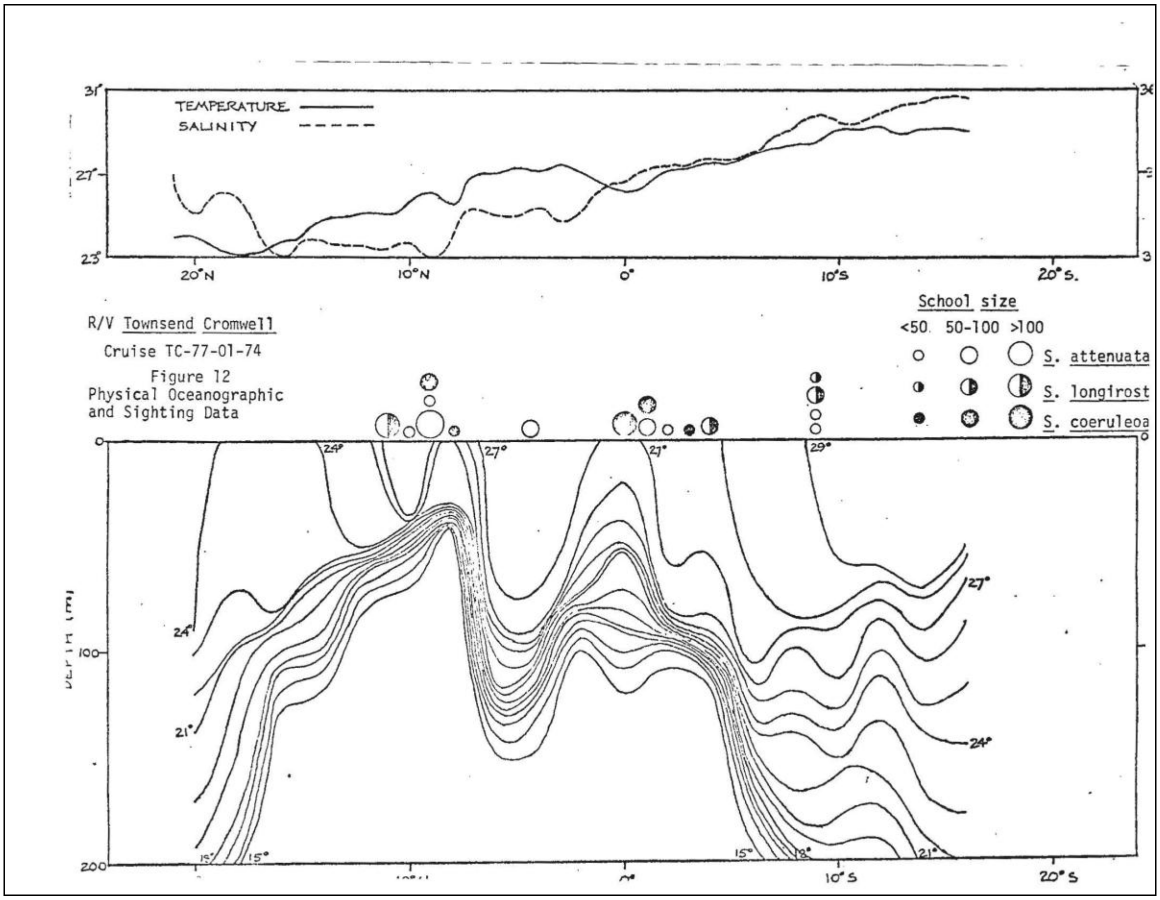
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



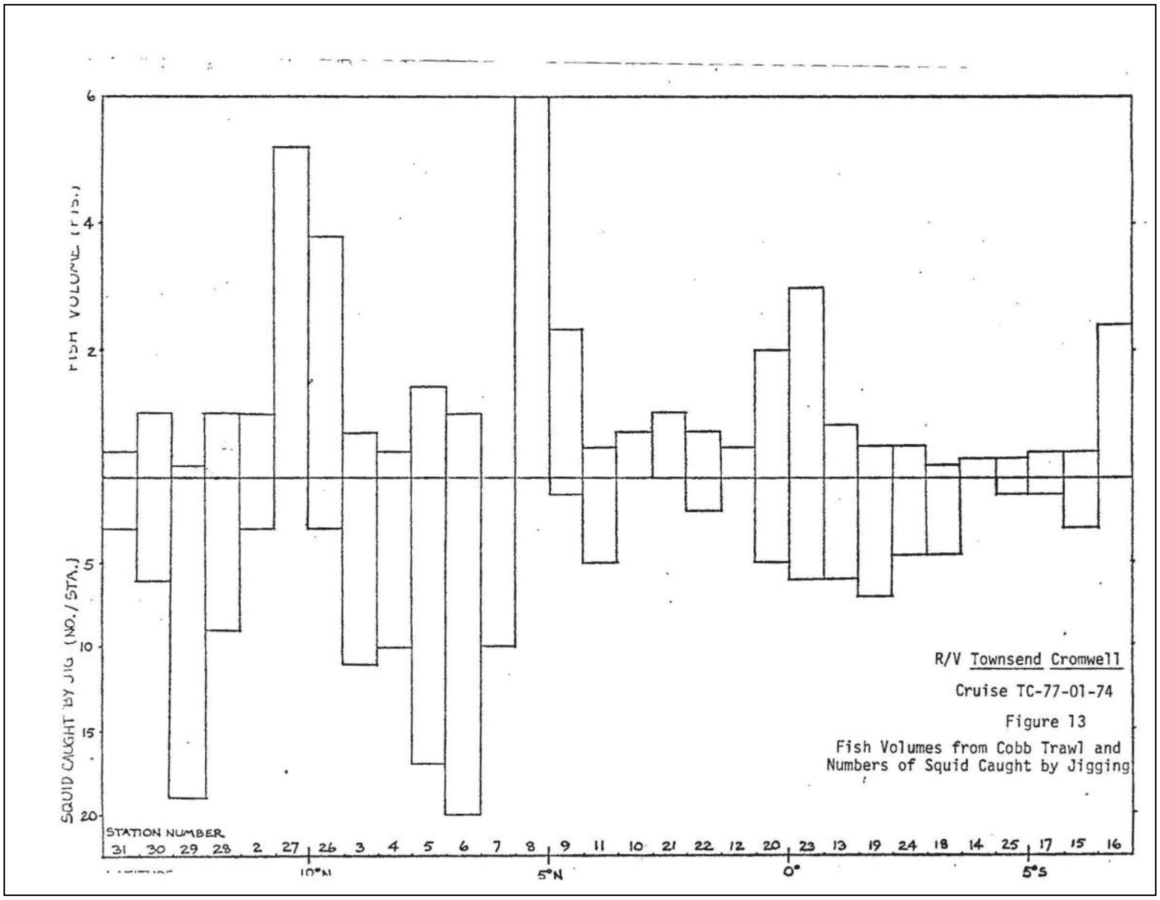
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



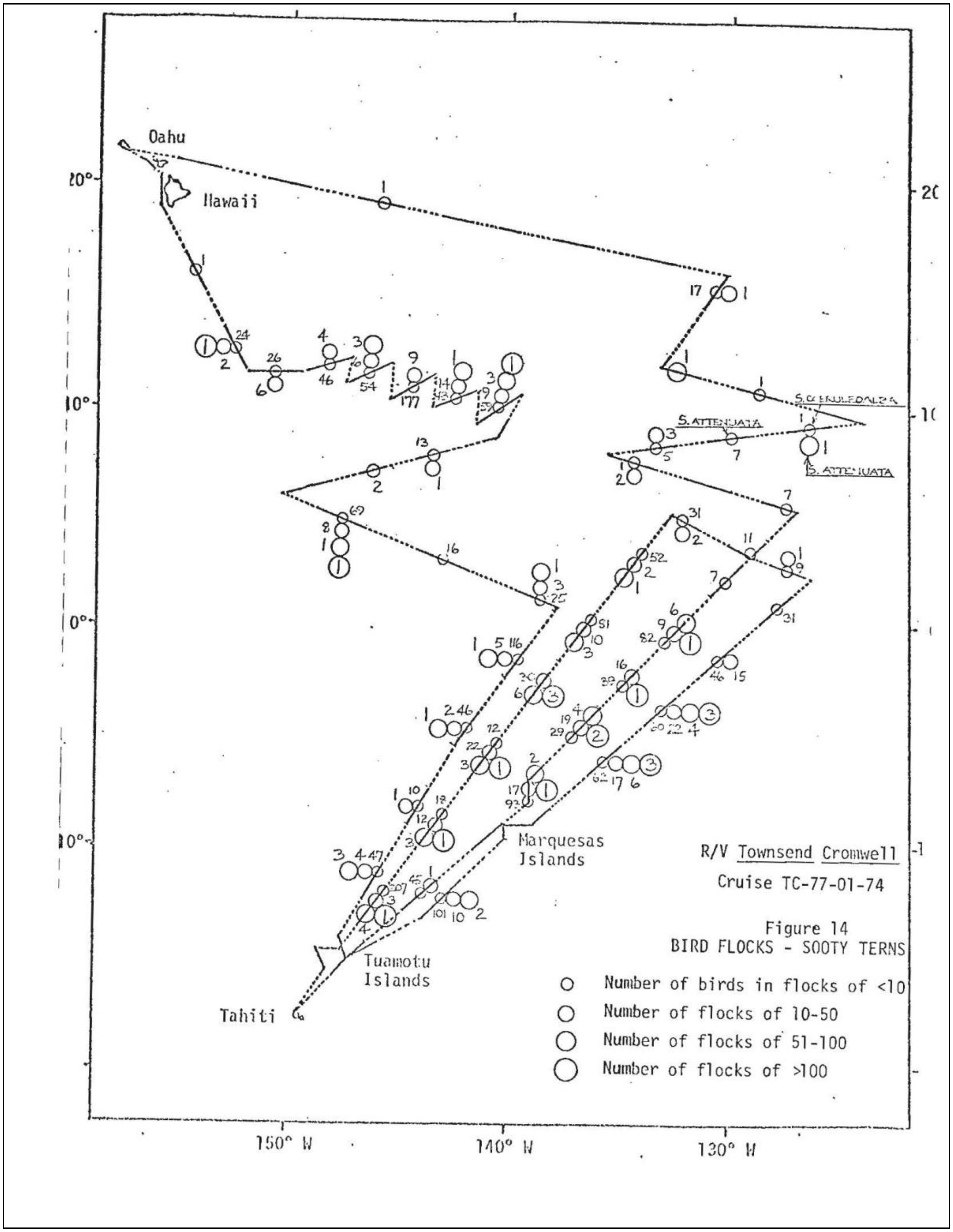
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



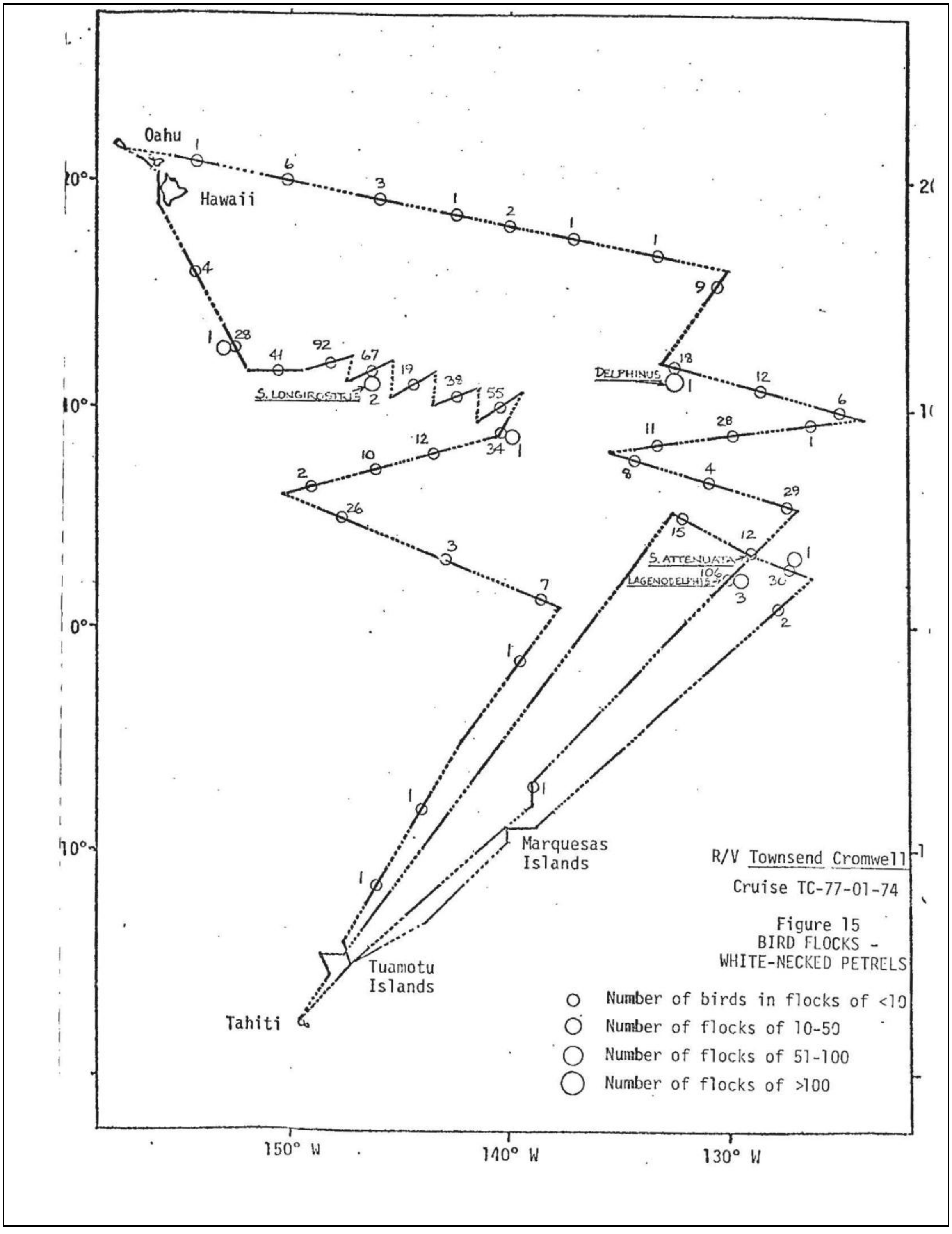
Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



Appendix 2H. Cruise report for SWFSC Cruise 0214. (Continued)



Appendix 2I. Cruise report for SWFSC Cruise 0216.

Southwest Fisheries Center
P.O. Box 271
La Jolla, CA 92038

~~#252~~ cruise 216

September 2, 1976

To: Bill Fox
Thru: David Au
Bill Perrin

From: Wayne Perryman

Subj: Results of Oceanographer DOMES Cruise, Leg 7.

The Oceanographer departed Honolulu on 29 July and steamed to DOMES Site A (8°27'N, 150°47'W). At this location a current meter array was deployed and a 13 hour CTD was conducted. The ship then steamed to the Equator at 150°W. Here another current meter array was deployed. For the next 12 days the ship did current profiling work at stations spaced 30nm apart between 1°30'N and 1°30'S along 150°W. During this period the ship was only underway about 3 daylight hours per day. On 17 August, one of the ship's company suffered a heart attack and the ship steamed directly to Honolulu, arriving on 20 August.

The 20X spotting binoculars were mounted on the ship's flying bridge (Ht. of eye about 48 Ft.) A watch for mammals was maintained for 8-11 hours a day throughout the cruise.

Fifteen schools of porpoise were sighted (See Fig. 1). These schools were concentrated near the Equator and along the ridge between the counter-current and the north Equatorial current (Fig. 2, 3). All of the schools sighted ran from the ship. This may indicate that the tuna seiners are fishing further to the west than our data shows or that these animals have moved to the west from the exploited region.

During the northern summer, the northern trades move farther north and there is a marked change in the physical oceanography of this region. The mixed layer warms 4-5°C, the thermocline becomes more intense, the counter-current is much stronger, and the upwelling along the Equator increases. All of these factors tend to extend the oceanographic regime of the eastern tropical Pacific to the west. It seems likely that these consitions result in a seasonal east/west shift of porpoise population in the tropical Pacific.

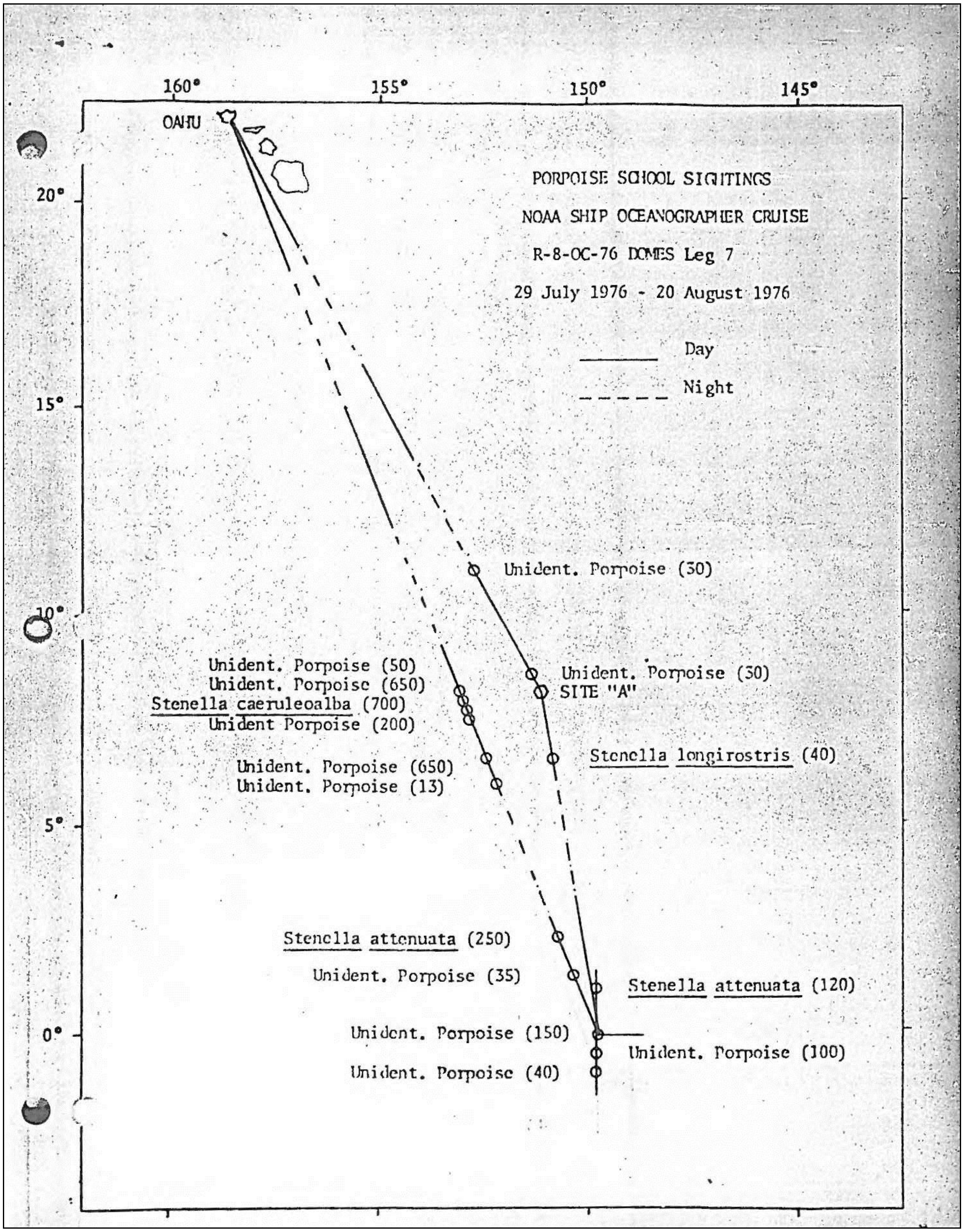
Appendix 2I. Cruise report for SWFSC Cruise 0216. (Continued)

In addition to the sightings mentioned above, nine whale sightings were recorded. During the 12 day period we spent working along the Equator, numerous large flocks of fish eating birds (terns, shearwaters, frigate birds) were sighted. The splashes of large fish were often visible under these flocks.

The *Oceanographer* is committed to DOMES work in the tropical Pacific through November of this year and for her full season next year. The ship is an excellent sighting platform and we should be able to get an observer aboard for any leg that looks interesting.

0923/MP/sw

Appendix 2I. Cruise report for SWFSC Cruise 0216. (Continued)



Appendix 2J. Cruise report for SWFSC Cruise 0232.

NMFS Cruise 232

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

CRUISE REPORT

VESSEL AND EQUIPMENT: R/V Oceanographer, Cruise RP-9-OC-77 Porpoise Cruise No. 232.

CRUISE PERIOD: March 24, 1977, to April 15, 1977

ITINERARY: Depart Seattle, March 24, 1977
Arrive Seattle, April 15, 1977

OBJECTIVES:

1. To deploy Equa-2 buoy at 0° latitude, 125°W longitude.

2. To conduct CTD measurements near Equa-2 to 500 m, every hour for 13 hours.

3. To conduct CTD measurements at regular intervals from 2°S latitude to 10°N latitude.

4. To collect data as to the distribution, population density and behavior of marine mammals and associated organisms encountered during this cruise in the Tropical Pacific.

PROCEDURE: The R/V Oceanographer departed Seattle, Washington, on March 24, 1977, and proceeded south along the 125°W longitude to the Equator. There the Ocean Atmosphere Response Studies (OARS) group deployed their Equa-2 buoy. After the Equa-2 deployment, the ship began its 13-hour conductivity, temperature, depth (CTD) measurements near the site. After completion of the CTD's near the site, the R/V Oceanographer steamed to 2°S latitude and 125°W longitude where additional CTD casts were conducted beginning at 2°S and at 0.25° intervals to 2°N. From 2°N to 10°N, CTD's were performed at every 1° interval. At 10°N, the ship completed its measurements and proceeded north returning to Seattle on April 15, 1977.

Appendix 2J. Cruise report for SWFSC Cruise 0232. (Continued)

Marine mammal observations were recorded during daylight hours from the flying bridge throughout the cruise. For this purpose, a pair of 20X shipboard binoculars were mounted on the bridge. Actual hours on marine mammal watch averaged approximately 8 hours per day. Except for a large bird flock, the ship did not change course to approach any mammals.

RESULTS: Ten dolphin schools were sighted during the cruise. Most of the sightings were concentrated near the equator and along convergence lines between the South Equatorial Current and the Equatorial Countercurrent. Of these sightings, only one school was seen in association with a flock of birds (frigate birds, shearwaters, terns, petrels). Perhaps the most interesting of the sightings was a large school of Fraser's Dolphin (*Lagenodelphis hosei*) near the equator.

In addition to the dolphin sightings, there were 12 whale sightings. Most of these animals were also observed in the region near the equator. Included in this category were four sightings of unidentified mammals which were either dolphin or small whales.

Several large bird flocks were encountered in the area south of the equator with a large concentration of birds at 2°S latitude. The majority of these birds were identified as sooty terns (*Sterna fuscata*). Some fish jumpers and many fish-like splashes were seen in association with several of these flocks. Of interest was the fact that no dolphin schools were seen in association with these bird flocks in this apparent productive and active area.

SCIENTIFIC PERSONNEL:

Eugene Duley, Chief Scientist, PMEL
William Parker, PMEL
James Lambert, SWFC

Date: June 29, 1977

Prepared by: James Lambert
James Lambert
Biological Technician

Date: 7/1/77

Approved by: Izadore Barrett
Izadore Barrett
Acting Center Director

Appendix 2J. Cruise report for SWFSC Cruise 0232. (Continued)

Table 1. Marine Mammal Sightings R/V *Oceanographer* Cruise

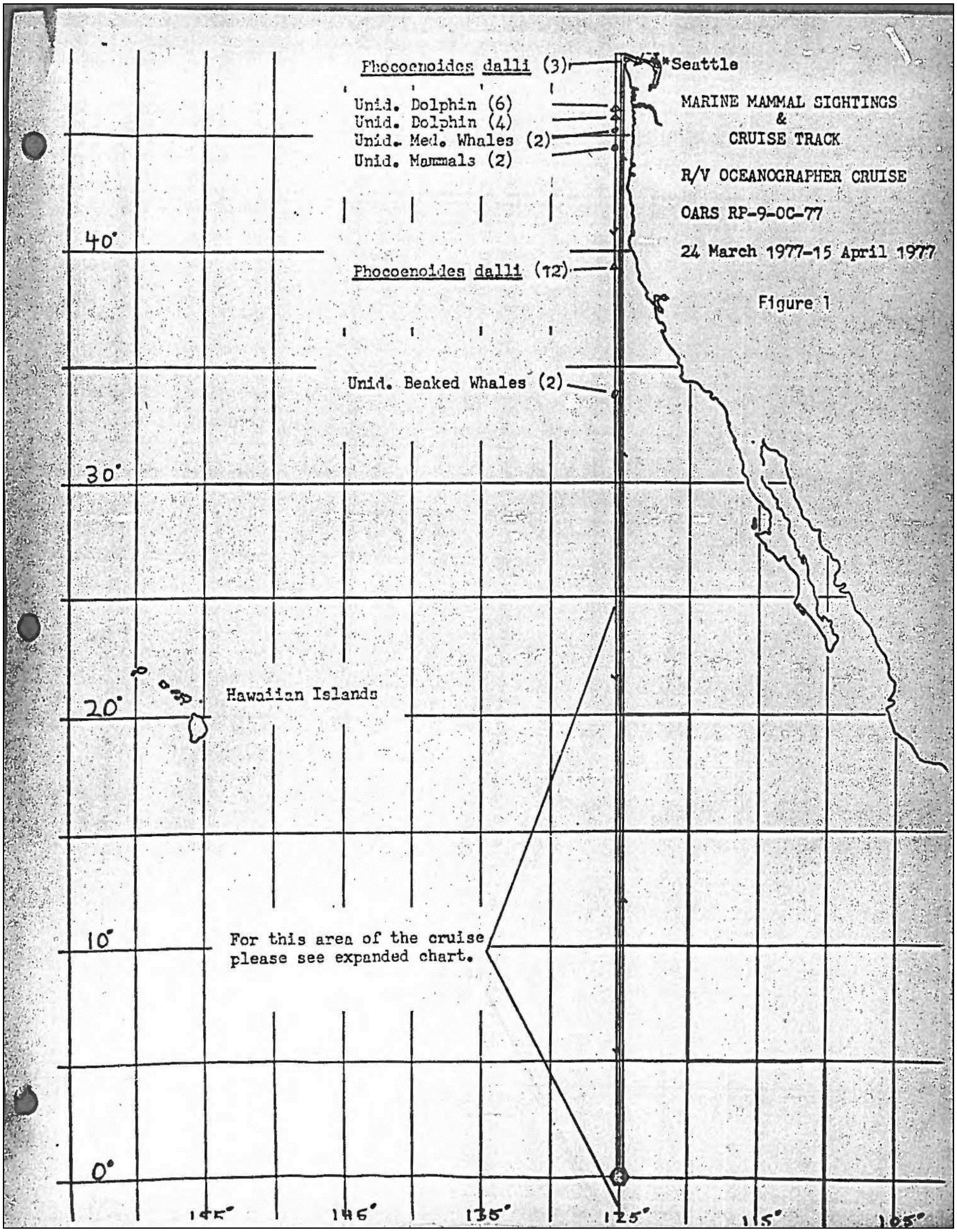
March 24 - April 15 1977

Date	Time	Latitude	Longitude	Species	School Size	Notes
3/25	0728	46°05'N	125°25'W	Unid. dolphins	6	
3/25	0948	45°41'N	125°29'W	Unid. dolphins	4	
3/25	1152	45°13'N	125°32'W	Unid. med. whales	2	
3/25	1448	44°37'N	125°38'W	Unid. mammals	2	
3/26	1310	39°25'N	125°49'W	*Phocoenoides dalli*	12	No birds
3/27	1322	33°55'N	125°26'W	Unid. beaked whales	2	No associated organisms
4/2	0643	3°39'N	125°28'W	*Physeter catodon*	8	No birds
4/2	0740	3°29'N	125°26'W	*Ziphius cavirostris*	1	No associated organisms
4/2	0837	3°17'N	125°24'W	Unid. dolphins	40	No birds
4/2	1244	2°24'N	125°14'W	Unid. dolphins	500	1 Frigate bird, 15 unid. shear/petrels
4/4	1037	0°08'S	125°59'W	*Grampus griseus*	10	No associated animals
4/4	1137	0°22'S	125°03'W	Unid. dolphins/small whales	2	No birds
4/4	1303	0°39'S	125°03'W	Unid. lg. baleen whale	2	No birds
4/4	1345	0°48'S	125°08'W	Unid. dolphins/small whales	5	

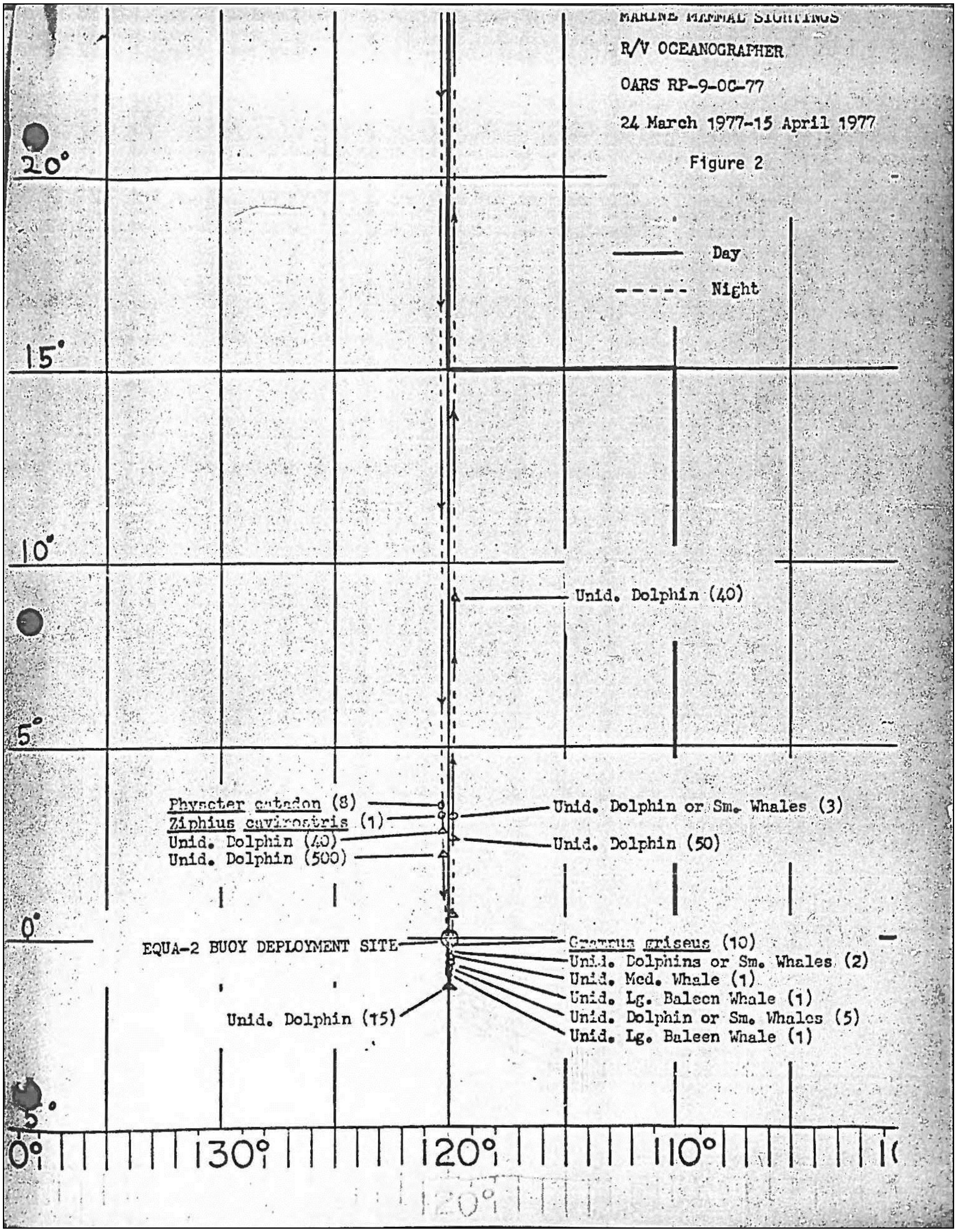
Appendix 2J. Cruise report for SWFSC Cruise 0232. (Continued)

Date	Time	Latitude	Longitude	Species	School Size	Notes
4/4	1410	0°54'S	125°07'W	Unid. lg. baleen whale	1	30 Sooty Terns, 10 shear/petrels 1/8 mile away
4/4	1838	1°56'S	125°00'W	Unid. dolphin	15	No birds
4/5	0839	0°30'S	125°00'W	Unid. med. whale	1	No birds
4/5	1826	0°40'N	125°00'W	Lagenodelphis hosei	375	No birds
4/6	0740	2°36'N	125°04'W	Unid. dolphins	50	No birds
4/6	1125	3°16'N	125°03'W	Unid. dolphins/small whales	3	
4/7	1803	9°01'N	125°59'W	Unid. dolphins	40	No birds
4/15	0747	48°05'N	123°21'W	Phocoenoides dalli	3	No birds

Appendix 2J. Cruise report for SWFSC Cruise 0232. (Continued)



Appendix 2J. Cruise report for SWFSC Cruise 0232. (Continued)



Appendix 2K. Cruise report for SWFSC Cruise 0234.

PERRIN'S COPY

CRUISE SUMMARY OF

THE US/USSR COOPERATIVE

MARINE MAMMAL OBSERVATION

AND TAGGING CRUISE ABOARD THE

R/V ZHARKII (APRIL-MAY 1977)

SERGE BIRK

NATIONAL MARINE FISHERIES SERVICE

TUNA/PORPOISE MANAGEMENT BRANCH

SAN DIEGO, CALIFORNIA 92101

INTRODUCTION

A cooperative whale tagging and observation cruise aboard the Soviet research whale catcher vessel Zharkii was sponsored by the All Union Research Institute of Marine Fisheries and Oceanography of the Soviet Union and the Northwest and Alaska Fisheries Center of the National Marine Fisheries Service (NMFS). The purpose of the research project was to provide information on cetacean biology, distribution, abundance and movements needed to formulate rational conservation and management regulations, particularly for the commercial harvest of sperm and Bryde's whales. The proposed cruise plan was to take place within the area between 10°S. Lat. to 10° N. Lat. and 120° E. Long. to 150° E. Long. The American participant was to board Zharkii on March 25, 1977 at Suva, Fiji and disembark at Honolulu, Hawaii at the termination of the cruise. The actual cruise plan was modified considerably (figure 1).

Under the provisions of the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973, a permit to tag and take selected marine mammals was issued to the Northwest and Alaska Fisheries Center. The designated permit holder was Serge Birk, Fishery Biologist from the Tuna/Porpoise Management Branch, NMFS, San Diego, California. Mr. Birk was selected as the U.S. scientist to participate in the cooperative US/USSR cruise because of his marine mammal observation experience aboard U.S. commercial tuna purse seiners and his ability to speak fluent Russian. Two scientists from the Pacific Research Institute of Fisheries and Oceanography (TINRO) constituted the Soviet research staff. Dr. A. A. Berzin, Chief of Cetacean Research Laborarory, TINRO was the designated cruise leader and A. A. Kuzmin, Marine Mammalogist, TINRO, was in charge of tagging efforts.

The cooperative cruise was delayed for the following reasons: Zharkii was in port at Suva on March 18th and 19th with no knowledge of the expected rendezvous with the American participant on March 25; Zharkii was involved with oceanographic research at sea when the American participant arrived at Suva on March 22; and, Soviet scientists Berzin and Kuzmin were not onboard Zharkii when the American participant boarded at Suva.

LOGISTICAL PROBLEMS

The Master of Zharkii received instructions from Moscow to return to Suva on April 4th to receive the American participant. The vessel Zharkii departed Suva on April 5th. The Soviet scientists Berzin and Kuzmin were onboard the research trawler Poseidon in the area of New Caledonia. Zharkii rendezvoused with Poseidon on April 12th and Dr. Berzin and Mr. Kuzmin were transferred aboard. The Master of Zharkii and Dr. Berzin speculated on the authority of the permit issued to the Northwest and Alaska Fisheries Center to tag and take marine mammals in U.S. territorial waters. Zharkii surveyed areas of New Hebrides, New Caledonia, Tonga and Fiji Islands until confirmation to proceed into U.S. waters was granted from Moscow. Optimism of continuing the cruise to the Hawaiian Islands as planned was low and Zharkii rendezvoused with the whale factory ship Russia to discuss the problem with officials onboard. Zharkiireceived data on recent sperm whale sightings in the area from officials aboard Russia and used the information to salvage Zharkii's cruise plan by surveying areas of recent sperm whale sightings observed by Russia. During the last week of April Zharkii received instructions from Moscow to terminate the cooperative cruise at Suva, Fiji and that Zharkii was expected at Vladivostok, U.S.S.R. on May 22nd to be reconverted for commercial whaling purposes.

All communications with the Soviets were in the Russian language. This should be a consideration for future placements. The American participant had no difficulty in communicating with the Master, and Dr. Berzin during briefing sessions that were held periodically to keep him informed on the status of the cruise. On many occasions the American participant knew the nature of the briefing sessions through scuttlebutt before actual meetings took place. The degree and completeness of data collected by the American participant was related to his ability to speak, read, and write in the Russian language. The Soviets were consistent in communicating with the American participant and making available pertinent information greatly aiding cooperative data collection. They should be acknowledged for their openness.

The problems that arose during the cooperative cruise centered on extenuating circumstances concerning the placement of the American participant and the Soviet scientists onboard the vessel Zharkii which had not been notified of its participation with the scheduled research cruise. This problem would not have been developed if all parties involved were informed of the proposed cruise itinerary.

METHODS

A continuous marine mammal watch was maintained from sunrise to sunset by at least four experienced cetacean observers. The majority of sightings were observed initially by the mastman. When any cetaceans were sighted a concentrated effort was made to approach the animals for positive identification, photographic documentation and tagging. Taggings were accomplished by "Discovery Type" tags fired from a double barreled twelve gauge shotgun by two men located on the bow of the vessel. Firing distance was about ten to thirty meters from the animal.

Proper tagging location for sperm whales was behind the dorsal hump. Attempts were made to tag all sperm whales sighted. The tagging operation was considered successful only if the tag was embedded securely in the animal. If the initial tag was not secured, a second tag was discharged. The mastman directed the vessel during tagging operations and provided actual counts of the animals sighted. A complete set of data documenting location, species composition, school size estimates and swimming movement direction were recorded on Marine Mammal Sighting Record forms and sighting efforts were cross-referenced by recordings on Shipboard Mammal Watch Effort Record forms. All such forms were provided by the National Marine Fisheries Service (Appendix I).

Oceanographic stations were predetermined by oceanographers onboard Zharkii and were associated with marine mammal sightings (figure 1). At each station the date, time, position, wind direction, wind speed, swell direction, sea state, cloud cover, air pressure and air temperature were recorded. In addition, a 500 meter Nansen bottle cast was made to determine oxygen content, salinity, and temperature of the sampled water column. These data were made available to the American participant (Appendix II).

RESULTS

Four hundred and fifty-two sperm whales were observed of which fifty-eight were tagged (Table 1). All tagged whales exceeded seven meters in length. A possible sperm whale breeding ground was discovered near Tonga Island, and a population of sperm whales characterized by a thick dorsal hump was found south of the Fiji Islands. Documentation of a sighted animals's sex was determined by group structure and animal size. Solitary animals, ten meters or greater in length were determined to be mature males. Animals seven to ten meters in length grouped in pods with calves were determined to be females. Young bulls generally were paired and were approximately eight to ten meters in length. Calves were not tagged and proved impossible to sex. On at least one sighting, a male, female, and calf were observed together.

Whale behavior was observed during tagging efforts. Tagging became progressively difficult as tagging efforts increased. Tagged sperm whales exhibited communication capabilities with untagged animals. Animals avoided tagging by remaining motionless or submerged, changing directions and circling towards the direction of the sun or by making a deep dive. Calves exhibited that they could make radical course changes by flexing their body, remain submerged for ten minutes and travel at speeds of ten knots. Many females were tagged by chasing a calf until the vessel was led to the parent. On many occasions all animals would be submerged. The vessel would circle slowly or drift until a blow was visible or a surface slick caused by the movements of the whale's flukes would appear. Animals required at least six blows before attempting a deep dive. During tagging, if an animal's head was exposed during the tagging effort it would blow then dive and if the animal's head was submerged but the dorsal hump was exposed, it would expel air through the blowhole below the surface and then dive. Many animals defecated when receiving a tag and one animal was recorded as injured when it exposed a red blow.

The Soviet scientists were extremely cautious during tagging operations not to damage any animals.

SUMMARY

The US/USSR cooperative research cruise generated useful data for the management of sperm whale stocks. It is possible that a non-migratory population of sperm whales exists in the area around Tonga island chain. The Soviets intend to document this premise through data gathered from returned tags. Scientific members onboard Zharkii expressed an interest to continue cooperative US/USSR research and possibly schedule another cruise to survey the area originally planned. Scientific records and photographs resulting from the cruise aboard the vessel Zharkii will be submitted at a future date.

Appendix 2K. Cruise report for SWFSC Cruise 0234. (Continued)

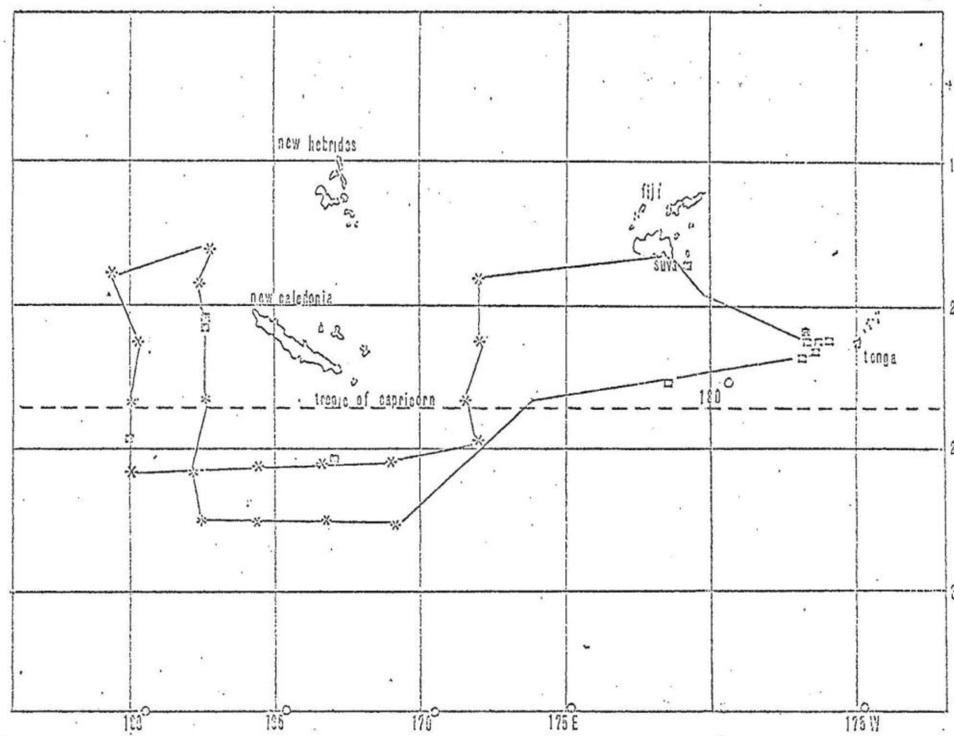


Figure 1. Cruise tract for the US/USSR cooperative research cruise onboard the Zharkii, April 5, 1977 to May 2,1977. Key: ¤ Marine mammal sightings, * oceanographic stations

TABLE 1 Summary of marine mammal sightings and tagging efforts during the cooperative US/USSR observation cruise aboard the Soviet whaler Zharkii, April 5, 1977 to May 2, 1977.

DATE	POSITION	SPECIES SIGHTED	# ANIMALS OBSERVED	# ANIMALS TAGGED
4/10/77	25°32' S. 167°08' E.	*Physeter catadon*	17	1
4/12/77	24°45' S. 160°00'E.	*Physeter catadon*	10	1
4/16/77	20°21'S. 162°39' E.	Unidentified whale	1	0
4/16/77	20°38' S. 162°41' E.	*Physeter catadon*	90	11
4/24/77	22°47' S. 178°47' E.	*Physeter catadon*	129	6
4/26/77	22°50' S. 176°50' W.	*Physeter catadon*	11	3
4/27/77	22°13' S. 176°23' W.	*Physeter catadon*	35	6
4/27/77	22°07' S. 176°25' W.	*Physeter catadon*	17	7
4/27/77	21°52' S. 176°18' W.	*Physeter catadon*	35	3
4/28/77	21°33' S. 176°00' W.	*Physeter catadon*	33	11
4/28/77	21°15' S. 175°51' W.	*Physeter catadon*	25	9
5/2/77	18°26' S. 179°17' E.	*Physeter catadon*	50	0
		TOTAL	453	58

Appendix 2L. Cruise report for SWFSC Cruise 0310.

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

CRUISE REPORT

VESSEL AND EQUIPMENT:	R/V *Oceanographer* DOMES Cruise RP-7-02-77. Porpoise Cruise No. 310.
CRUISE PERIOD:	June 27, 1977 - July 29, 1977
ITINERARY:	Depart San Diego: June 27, 1977 Arrive Seattle: July 29, 1977
OBJECTIVES:	To deploy an array of near-bottom current meters (EBW-3) and conduct supporting CTD measurements. To deploy acoustic navigation transponders. To obtain stereo-photographs of the sea floor using acoustic navigation control. To conduct magnetic and bathymetric observation including a specific 3.5 kHz sub-bottom survey in the mine test area. To conduct dye dispersion experiments and evaluate the performance of drogued buoys. To obtain samples for radon and nitrous oxide studies throughout operating area. To obtain gravity cores in a previously surveyed and sampled area near 126°, 15°15'N. To recover array of near-surface current meters (EQUA-2) near 125°W, 0°N and conduct supporting CTD measurements.

Appendix 2L. Cruise report for SWFSC Cruise 0310. (Continued)

To collect nodules, using an SBT trawl for studies of bacteria in nodule samples.

To obtain radiation and meteorological observations.

To collect data as to the distribution, population density and behavior of marine mammals and associated organisms encountered during this cruise in the eastern tropical Pacific Ocean.

PROCEDURE: The R/V *Oceanographer* departed San Diego on June 27, 1977, and proceeded south-southwest towards "Site C" (15°N/125°W), the prime area of investigation by the Deep Ocean Mining Environmental Studies (DOMES) group. Approximately 6 days were spent in transit from San Diego to "Site C." This included a 2-day delay in which the ship returned towards San Diego in order to rendezvous with a Coast Guard aircraft containing medical supplies. July 3, 1977-July 7, 1977, were spent in the area of "Site C" where the DOMES group conducted various research projects. On July 8, 1977, the *Oceanographer* departed "Site C" and steamed south along 125° longitude to the equator, arriving late July 10, 1977. In this area, the ship conducted a 13-hour CTD-time series and successfully recovered the Equa-2 Current Array deployed on a previous cruise. After recovery of Equa-2, the *Oceanographer* steamed immediately to 2°S latitude, 125°W longitude where CTD measurements to 1000 m were begun. CTD measurements were taken along 125°W longitude at 2°S, 1.5°S, 1.25°S, 1.0°S, 0.75°S, 0.5°S, 0.25°S, 0°, 0.25°N, 0.5°N, 0.75°N, 1.0°N, 1.25°N, 1.5°N, 2°N, 3°N, 4°N, 5°N, 6°N, 7°N, 8°N, 9°N, and 10°N. These CTD measurements were completed early on July 15, 1977. Upon completion, the ship returned to "Site C."

The ship remained at "Site C" from July 16, 1977-July 21, 1977, conducting further pre-mining environmental research. Mid-afternoon July 21, 1977, the DOMES group completed their investigations and the *Oceanographer* proceeded north returning to the Pacific Marine Center on July 29, 1977.

Marine mammal observations were conducted during daylight hours from the flying bridge throughout the cruise. Observations at all other times were conducted on an on-call basis. A pair of 20 X 120 mm, USN MK3 shipboard binoculars were mounted on the flying bridge. Also, a pair of Pentax 8 X 36 mm and a pair of Zeiss 15 X 60 mm handheld binoculars were available. Actual hours on marine mammal watch averaged from 7-9 hours per day.

All mammal observations were conducted on a non-interference basis with the primary objectives of the cruise. Due to the numerous projects in the cruise schedule, the ship did not alter course, with the exception of one small dolphin school, to approach marine mammals. A running account was maintained of all birds observed during mammal watch hours. A similar account was maintained for meteorological events to qualify the mammal observation data.

On an opportunistic basis during night stations throughout the cruise, squid were captured and preserved for future studies.

RESULTS: The following discussion pertains to the observations and data collected by James Lambert.

Seventeen dolphin schools were sighted during this cruise. Of these animals, only five were close enough to be identified. These were: Stenella coeruleoalba (two schools), Delphinus delphis, Lagenorhynchus obliquidens and Phocoendoides dalli. These sightings were not concentrated but rather well dispersed along the cruise track in the tropical and subtropical waters. However, a slight concentration of animals was seen in colder waters off the coast of Oregon and Washington. No bird flocks were seen associated with these dolphin schools in the tropical waters. Birds were seen in close association with a school of Lagenorhynchus obliquidens off the Washington coast.

In addition to the dolphin schools, 13 whale sightings were noted. Of these whale sightings, six were identified. These were: Grampus griseus (four schools), and Ziphius cavirostris (two schools). The whales sighted were also distributed in a similar pattern as the dolphin schools. On one occasion, birds were observed in close association with a group of whales.

Numerous flocks of Juan Fernandez/white-necked petrels (Pterodroma externa externa/cervicalis) were observed between 18°N latitude and 5°N latitude. Some of these flocks were associated with fish jumpers and fish "breezers." In addition, several flocks of sooty terns (Sterna fuscata) were sighted between 6°N latitude and the equator. Neither of these birds was seen associated with marine mammals.

Thirty-one specimens of pelagic squid were collected, preserved and returned to the SWFC for further study.

DISCUSSION: On a previous cruise in March-April 1977, to the same area (porpoise cruise #232), all marine mammal sightings were concentrated in the equatorial divergence region. No mammals were sighted north of 5°N latitude along the 125°W longitude in these tropical waters. However, on this cruise to the same area in June-July 1977, marine mammals were seen to be well distributed along the 125°W longitude from the region of the equator to 15°N latitude. This data may be indicative of seasonal movements of these tropical species of dolphins and whales. Future observations in this area would lend a better understanding as to the distribution of these animals on a seasonal or annual basis. This information would be very useful in formulating population estimates and in determining the overall distribution of these animals in the tropical Pacific.

SCIENTIFIC PERSONNEL:

PMEL (DOMES)

Barrett H. Erickson, Chief Scientist
Cdr. Otto Seffin, Field Operations
Robert H. Wing, Dye Dispersion Studies
LTJG Larry Parsons, Sea Floor Photography & Sampling
LTJG Lars Pardo, Drogue Buoy Operations
Ken Muth, Data Acquisition and Processing
Roy Newman, Electronic Support
Tom Jackson, Electronic Support
Pat Nelson, Technical Assistance

PMEL (Deep Sea Physics)

Connie Powell (U.W.) CTD Operations
Rick Miller (U.W.) EBW-3, EQUA-2 Operations

Rensselaer Polytechnic Inst.

Dr. Henry L. Ehrlich, Bacterial Activity on Nodules
Edward J. Arcuir, Bacterial Activity on Nodules

SWFC

James F. Lambert, Marine Mammal Observations

Date: September 21, 1977 Prepared by: James F. Lambert
James F. Lambert
Biological Technician

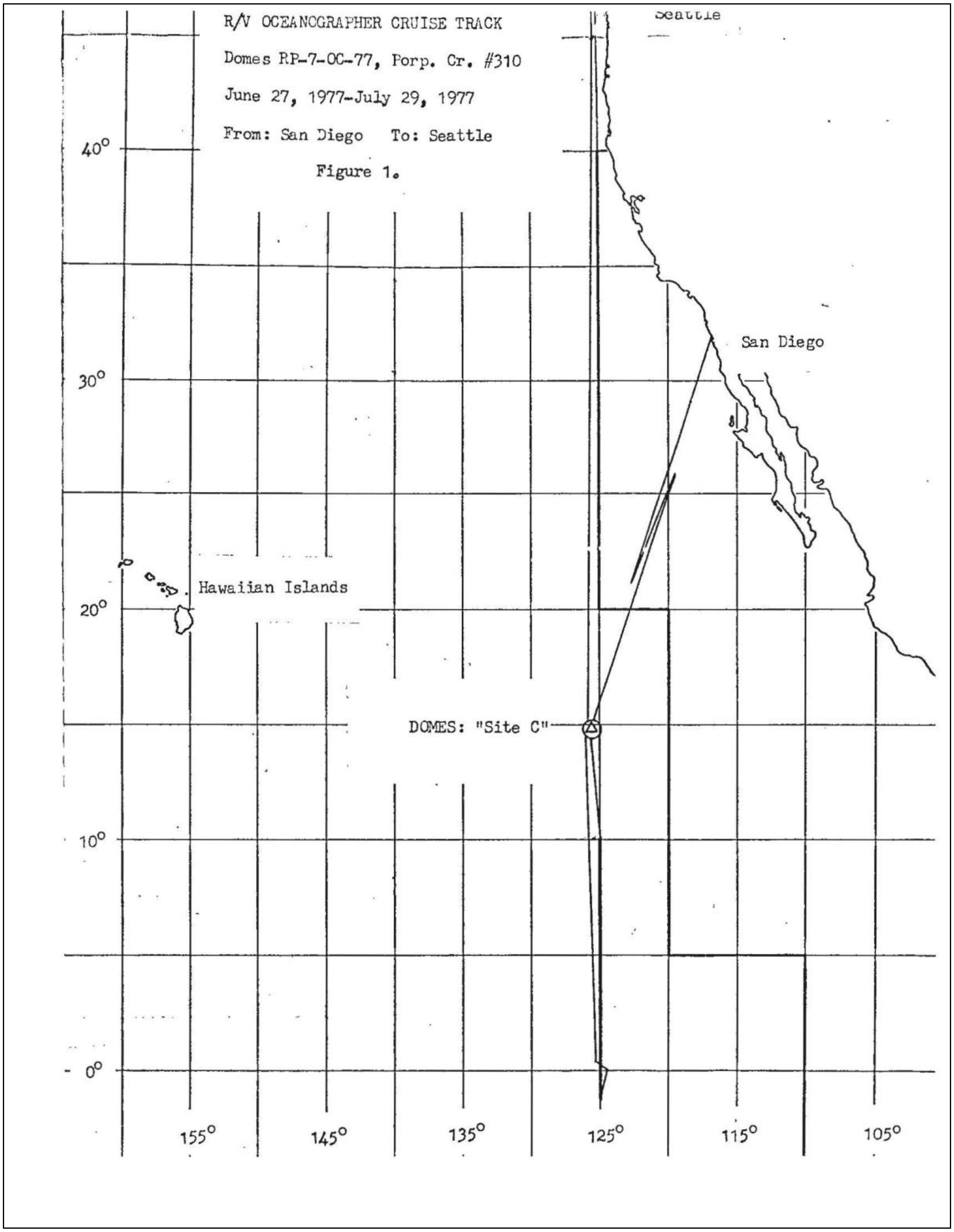
Date: Sept. 21, 1977 Approved by: Gary Sakagawa
for Izadore Barrett
Center Director

Appendix 2L. Cruise report for SWFSC Cruise 0310. (Continued)

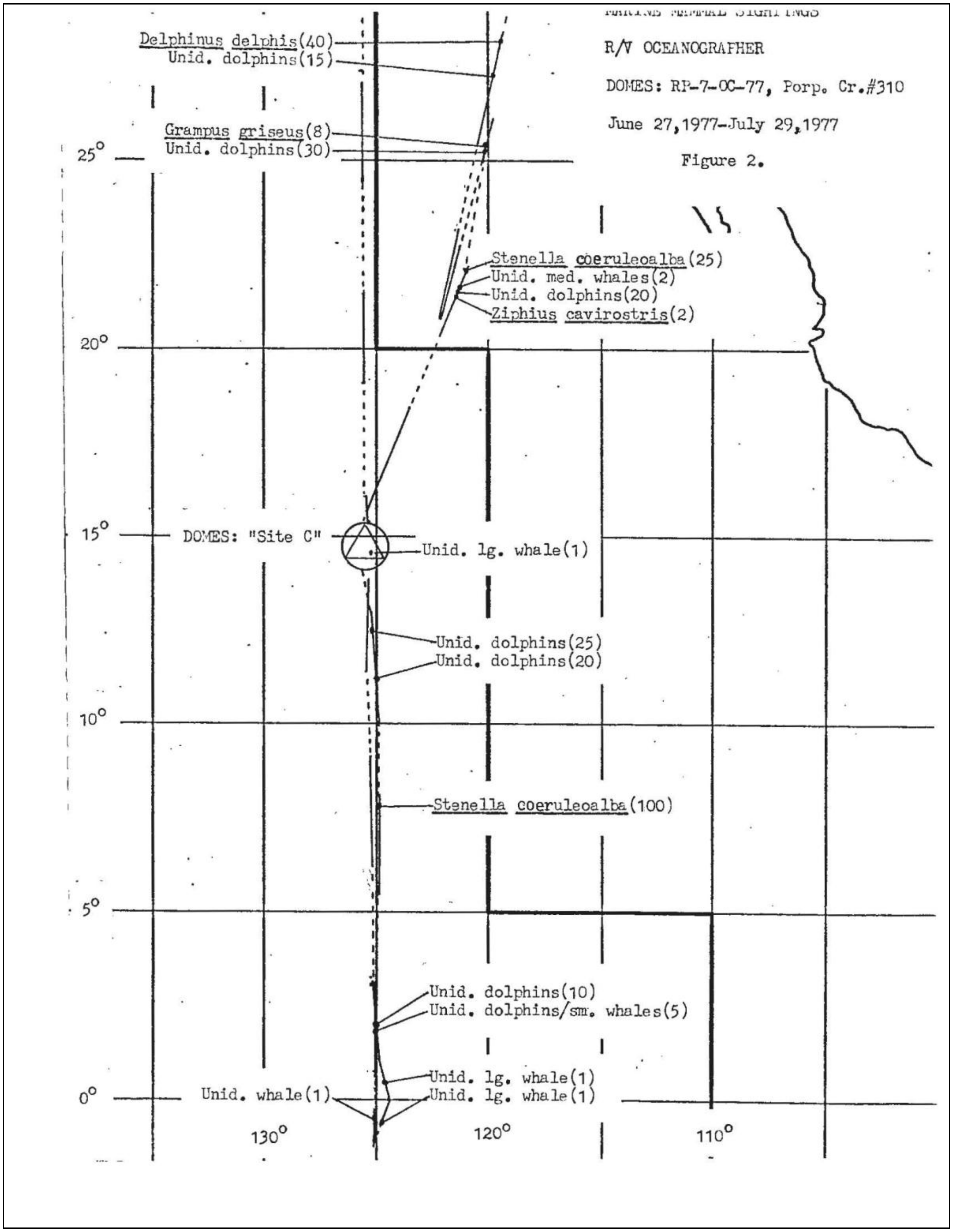
Table 1. Marine Mammal Sightings
June 27, 1977 - July 29, 1977

Date	Location		Species	School Size	Notes
6/28	27°55'N	119°38'W	*Delphinus delphis*	40	No birds
6/28	27°13'N	119°58'W	Unid. Dolphins	15	No birds
6/30	25°40'N	120°40'W	*Grampus griseus*	8	
6/30	25°30'N	120°45'W	Unid. Dolphins	30	No birds
7/1	22°23'N	122°13'W	*Stenella coeruleoalba*	25	No birds
7/1	21°51'N	122°25'W	Unid. med. whales	2	No birds
7/1	21°44'N	122°28'W	Unid. dolphins	20	No birds
7/1	21°32'N	122°35'W	*Ziphius cavirostris*	2	No birds
7/10	0°36'N	124°46'W	Unid. Lg. whale	1	No birds
7/11	0°42'S	124°46'W	Unid. Lg. whale	1	
7/12	0°34'S	124°59'W	Unid. whale	1	
7/13	2°00'N	125°00'W	Unid. dolphins/sm. whales	5	No birds
7/13	2°12'N	125°02'W	Unid. dolphins	10	No birds
7/14	7°45'N	125°00'W	*Stenella coeruleoalba*	100	No birds
7/15	11°03'N	125°03'W	Unid. dolphins	20	No birds
7/15	12°27'N	125°13'W	Unid. dolphins	25	No birds
7/16	14°35'N	125°29'W	Unid. Lg. whale	1	
7/26	41°21'N	125°31'W	Unid. dolphins	6	No birds
7/26	41°23'N	125°31'W	*Grampus griseus*	12	1 Storm petrel sp?
7/26	41°31'N	125°31'W	Unid. Lg. Whale	2	No birds
7/26	41°41'N	125°31'W	*Ziphius cavirostris*	1	No birds
7/26	41°47'N	125°31'W	Unid. Med. whale	1	No birds
7/26	42°36'N	125°29'W	*Grampus griseus*	7	No birds
7/26	42°47'N	125°31'W	*Grampus griseus*	15	
7/26	42°50'N	125°31'W	Unid. dolphins	1	No birds
7/27	44°49'N	125°33'W	Unid. dolphin/sm. whales	50	No birds
7/27	46°35'N	125°27'W	Unid. dolphin/sm. whales	80	No birds
7/27	47°09'N	125°26'W	Unid. dolphin/sm. whales	25	
7/27	47°23'N	125°20'W	*Lagenorhynchus obliquidens*	170	40 Sooty Shearwaters 5 Alcids, 10 Storm Petrels
7/27	48°03'N	125°03'W	*Phocoenoides dalli*	2	No birds

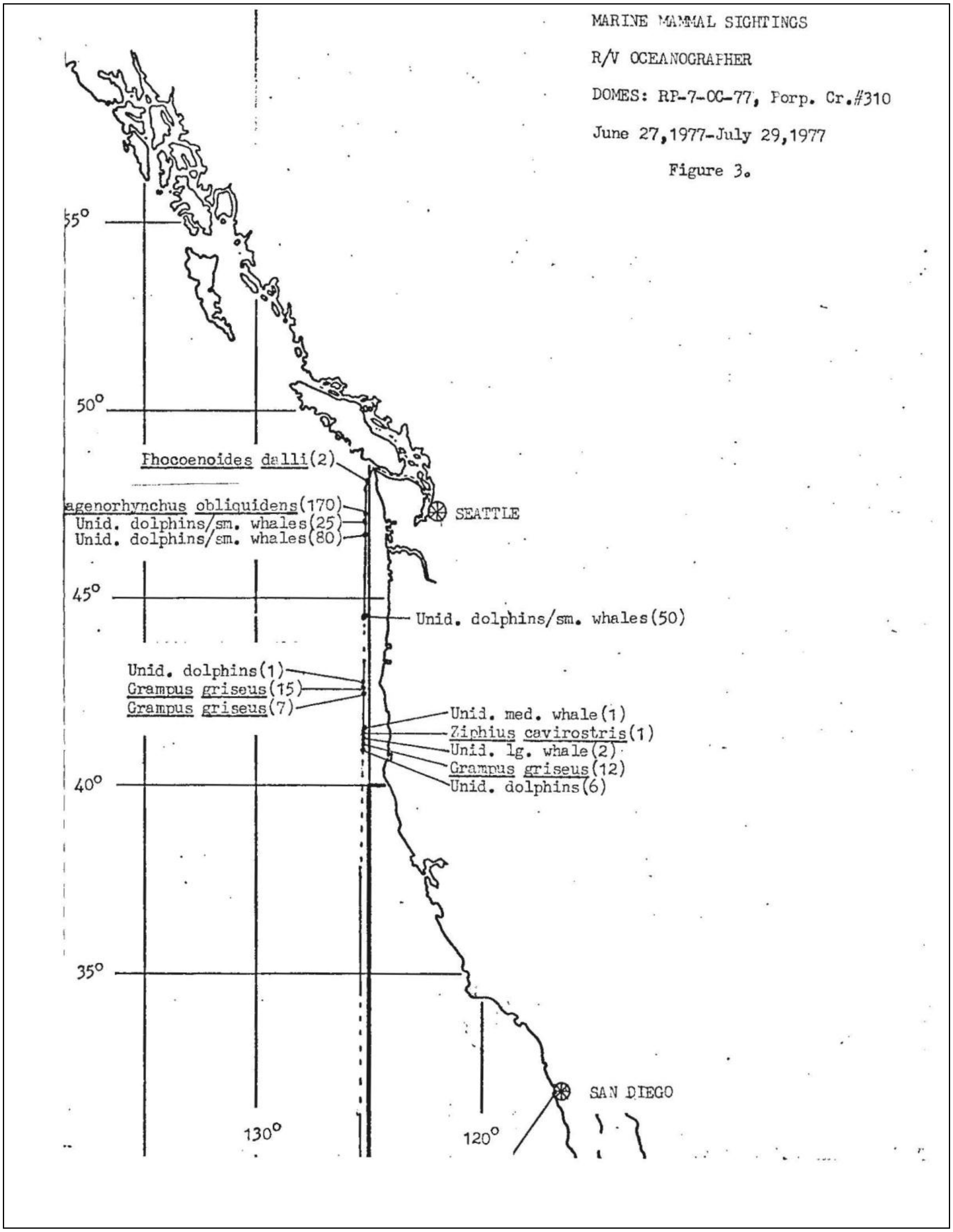
Appendix 2L. Cruise report for SWFSC Cruise 0310. (Continued)



Appendix 2L. Cruise report for SWFSC Cruise 0310. (Continued)



Appendix 2L. Cruise report for SWFSC Cruise 0310. (Continued)



Appendix 2M. Cruise report for SWFSC Cruise 0319.

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Marine Fisheries Service
SOUTHWEST FISHERIES CENTER
La Jolla, California 92038

CRUISE REPORT

VESSEL:	NOAA Ship David Starr Jordan Cruise No. DS-77-06 (113); Porpoise Cruise No. 319
CRUISE PERIOD:	October 3 - November 21, 1977
ITINERARY:	Depart San Diego: October 3, 1977 Arrive San Diego: October 6, 1977 Depart San Diego: October 6, 1977 Arrive Callao, Peru: October 26, 1977 Depart Callao, Peru: October 30, 1977 Arrive San Diego: November 21, 1977

OBJECTIVES:

To determine the effect of the summer-fall intensification of the Peru Current and the North Equatorial Countercurrent on the distribution of dolphin (porpoise) species.

To look specifically at dolphin distribution in the region of the equatorial front.

To study the characteristics of dolphin-seabird-fish associations in different regions of the tropical Pacific.

To study the distribution of epi- and mesopelagic fishes and squids using the universal trawl.

To collect data on the distribution and biology of pelagic ommastrephid squids.

To study the distribution of whale species.

OPERATIONS:

The Jordan cruised 10,340 miles along a predetermined track. A watch for marine mammals was maintained during daylight hours using USN, MK-3, 20X, 120 mm spotting binoculars mounted on each wing of the flying bridge. Sighting effort with the large binoculars was interspersed with scans of the nearby waters with the naked eye and hand-held binoculars. The watch periods were 2 hours in duration. The observers exchanged positions on the two bridge wings hourly. All sightings of marine mammals, birds, and tuna were recorded. In addition, sighting conditions were logged hourly. The cruise track and average daily sea state are given in Figure 1.

Upon sighting marine mammals, the ship usually approached the animals as close as practicable for identification, photography, school-size estimates, and behavioral observations. At the conclusion of the observations, the ship returned to its original course.

XBT's were taken at 6-hour intervals during the majority of the cruise. The thermosalinograph was annotated with each XBT drop and a surface water sample was taken daily for calibration of the salinity record. XBT surface temperatures were checked against the thermosalinograph temperature trace and a bucket thermometer.

A Universal midwater trawl was deployed at selected stations along the cruise track (Fig. 2). The trawl was set out with 150 m of wire and allowed to settle for 15 minutes. It was then retrieved in 25-fathom increments with a 5-minute period between each haulback.

At selected stations, squids were taken with jigs and dip net. The samples captured were identified to species, measured, and ranked according to their sexual maturity. A representative sample of the specimens were preserved and returned to the laboratory.

The migration and intensity of the deep-scattering layer was monitored periodically using the 30 kHz echo sounder. The paper sonar record was annotated regularly and returned to the Center for analyses.

RESULTS: A total of 196 separate cetacean sightings was recorded during this cruise (Tables 1-14). One hundred and twenty-nine of the sightings were of dolphins, including six species of porpoise, Risso's dolphin, pilot whales, and killer and false killer whales (Fig. 2). The remaining sightings were mostly sperm whales and unidentified large whales (Fig. 9).

A brief generalization for each species or species grouping follows. These results should be considered preliminary as the sighting records have not been fully reviewed.

Stenella attenuata (spotted dolphin), Fig. 3, Table 1

Of the 25 schools of spotted dolphins sighted, 11 were mixed with spinner dolphins (S. longirostris) and one school was mixed with striped and common dolphins (S. coeruleoalba and Delphinus delphis). School sizes ranged from 15 to 1130 animals, including associated species in mixed schools. The mean school size was 266 animals. Twenty of the schools were associated with birds.

The majority of the spotted dolphins were seen in the tropical water north of the equator and were concentrated along the frontal regions separating the North Equatorial Countercurrent and the Peru-South Equatorial Current. Eighteen of the 25 (72%) sightings of the species were found within this transition zone of rapidly changing sea surface temperature and salinity. Of the nine schools of spotted dolphin seen associated with tuna (and birds), seven were in this frontal region. Only three schools were seen south of the equator. These were in 21°-22°C water on the southern border of the Peru-S. Equatorial Current.

The behavior of the species was generally as noted in previous cruise reports. The one unique observation was of a mixed school of spotted, striped and common dolphins. Each species maintained its own integrety within the school. As the ship closed, the school separated by species with first the striped dolphins breaking off. A few minutes later the spotted and common dolphins split apart.

Stenella longirostris (spinner dolphins), Fig. 4, Table 2.

Sixteen schools of this species were sighted. In 11 of these schools, the spinner dolphins were mixed with spotted dolphins. Thirteen schools were associated with birds. Mean school size, including the mixed schools, was 283 with the range from 20 to 1100 individuals.

Three distinct forms of this species were observed. The animals sighted near 18° and 19°N latitude were classical eastern spinners (i.e., uniform dark grey, triangular to forward canted dorsal fins, etc.). These schools stayed low in the water, generally just "finning." The schools broke apart easily, and changed direction frequently, making the animals very difficult to follow. They approached the surface with such a flat trajectory that they could be seen swimming with 2 or 3 inches of their dorsal fin protruding above the surface. The three schools of spinner dolphins seen near 11°N latitude and 109°W longitude were also identified as eastern spinners. These animals frequently porpoised out of the water making them easy to follow. Unlike the schools at 18-19°N, a few individuals in each of these schools had mottled, cream white patches with indistinct margins around their anal region.

The remaining schools were all identified as whitebelly spinners. From examination of the sightings records and photographs, it appears that the four schools sighted to the west of the Galapagos Islands and the two schools south and southeast of these islands were from the "southwestern stock" of spinner dolphins. Photographs also revealed that some individuals from the school sighted at 3°12'N, 106°32'W appeared to be from this "southwestern stock."

Only three of the 16 sightings of this species occurred in the subtropical water south of the equator (all SW stock) and none were seen to the west of 100°W. All the remaining whitebelly spinners were sighted north of the equator along the temperature front that at this season marks the southern boundary of the tropical water. In contrast to this situation there were 12 sightings of spinner dolphin in the southern waters out to 106°W during the January-February cruise of the Jordan.

Stenella coeruleoalba (striped dolphin or streaker dolphin), Fig. 5, Table 3.

Fourteen schools of striped dolphin were sighted between 7°N and 7°S latitude. Only two schools were associated with birds, one of which was the only mixed school seen. This was the school consisting of spotted, striped, and common dolphins already mentioned.

This species was seen both in the tropical waters north of the equator and in the cool subtropical waters to the south. They were not closely associated with the frontal region and it is noteworthy that they were more often seen on days when spotted and spinner dolphins were not seen. South of the equator their distribution suggests that they are not affected by the cold waters of the Peru Current. One sighting was in 19°C water. The distribution was similar to that seen in January-February except this time no striped dolphins were seen west of 100°W whereas earlier in the year they occurred all along the southern portions of the cruise track to 125°W.

Delphinus delphis (common dolphin). Fig. 5, Table 14.

Common dolphins were seen six times in the coastal waters from San Diego to Guadalupe Island and five times west of Peru. Four of the five schools seen south of the equator were sighted within a 5-hour period. The fifth school, mixed with spotted and striped dolphins, was mentioned earlier. These southern animals had short rostrums, distinct thoracic patches, and less-distinct flank patches. They generally rode the ship's bow wave or made minimal efforts to avoid the ship's approach. School sizes ranged from 50 to 1000 animals and the mean was 284. Only the mixed school discussed earlier was accompanied by birds (two frigates).

Delphinus sightings occurred only in the temperate seas, including the cold waters of the Peru Current. Surprisingly none were seen about the equator, although observers aboard tuna seiners had reported their presence there during this same season. The equatorial distribution of *Delphinus* extends to about 110°W during January-February in a relatively narrow band about the equator and is associated then with tropical ocean conditions. The cool water prevailing there during this October-November period may have affected this distribution.

Grampus griseus (Risso's dolphin). Fig. 6, Table 5.

Small pods of this distinctive delphinid were sighted on 24 occasions. The small pods were generally clustered together so that if one group was sighted, it was not unusual to see three-to-five additional pods within the next few hours. All but one of these pods were sighted in the cool waters of the Peru-S. Equatorial Current. These sighting localities were similar to those recorded during the January-February period when warm sea surface temperatures prevailed. This time however Grampus schools were twice as numerous. School sizes ranged from two to 55 animals. Birds were not associated with them. These delphinids avoided the ship very slowly or swam towards the vessel.

Steno bredanensis (rough-toothed dolphin). Fig. 6, Table 6.

A single small school of this species was sighted in association with a pod of pilot whales. These porpoise avoided the ship but did not run hard. Once off the ship's course, the school would raft as the vessel passed.

Orsinus orca (killer whale). Fig. 6, Table 7.

This distinctive species was sighted on three occasions. Each time the pods of three to eight animals avoided the approaching vessel by making long dives and changing course underwater. One pod was attended by eight frigate birds.

Peponocephala electra (melon-headed whale) or Feresa attenuata (pygmy killer whale). Fig. 7, Table 8.

Three schools of these elusive, small blackfish were sighted. The first school, northwest of Clipperton Island, was not seen well and, since there were no photographs taken, it is impossible to tell whether it was Peponocephala electra or Feresa attenuata. The other two schools seen south of the equator, were larger and more cooperative. Their head shape and swimming behavior looked much more like that described for Peponocephala than for Feresa. The behavior and general appearance of these animals was the same as described in the previous Jordan-Cromwell cruise reports. The school seen at 2°S and 86°W was mixed with a pod of Risso's dolphins. The last school seen at 2°S, 95°W had a Steno or Tursiops mixed with it. It was initially sighted as a "breezer," then with individuals "porpoising" easily and unhurriedly about 1 mile distant. Later the animals dramatically increased speed and splashing when approached by a pod of pilot whales. School sizes ranged from 15 to 250 individuals. The last school was followed by a Parkinson's petrel (Procellaria parkinsoni).

Pseudorca crassidens (false killer whale). Fig. 7, Table 9.

On each of the three occasions that false killer whales were seen, they rode the bow wave at least briefly. This species bow rides most frequently when the vessel speed is slowed to 6-8 knots. At full speed, the animals' reaction to the ship is generally avoidance. School size ranged from 2-19 individuals. This species appears widely distributed in the eastern Pacific.

Tursiops truncatus (bottlenosed dolphin). Fig. 8, Table 10.

The majority of the 13 sightings of this species occurred in the waters of the Peru-S. Equatorial Current. Their distribution seems not to have been affected by the cool water in this area. The school sizes were small, the average being 27 individuals. Albatrosses and boobies were seen with three schools off the coast of Peru. On five occasions Tursiops were encountered in close association with pilot whales. These dolphins rarely ran from the vessel and often would bow ride for long periods of time. A small group of these animals were encircled by the Jordan's wake on one occasion. Although the ship was moving slowly and the wake relatively weak, the encircled Tursiops changed their direction of swimming whenever they encountered the wake. This group finally dove under the wake and rejoined the rest of the school.

Globicephala sp. (pilot whales). Fig. 8, Table 11.

Like the other larger delphinids, Globicephala sightings were much more common in the waters of the Peru-S. Equatorial Current than they were north of the equator where only three of the 19 total sightings occurred. This southern distribution was similar to that seen in January-February. School sizes were small, ranging from three to 10 animals. This species was frequently seen with Tursiops (five times), and was seen once each with Steno and Peponocephala. The Globicephala had the typical, thickly falcate dorsal fins and bulbous heads. Many also displayed a light saddle pattern just to the rear of their dorsal fins.

Physeter catadon (sperm whale). Fig. 10, Table 13.

The majority of the 15 sightings of sperm whales were made on one afternoon around 1°S latitude and 106°W longitude. As with the larger delphinids, this species was seen much more often in the waters of the south equatorial current.

Balaenopterid whales. (Fig. 11, Table 14)

Of the 18 sightings in this category, 14 were recorded as Balaenoptera sp., two were identified as B. edeni, and one was logged as B. borealis. Since time limitations did not allow the approach of every whale sighted, the unidentified whales were often seen only briefly and at considerable distances.

The identifications of B. edeni were based upon the presence of a pair of ridges on the whale's head, extending from the rostrum to the area adjacent to the blowhole. In all other aspects of appearance and behavior, these whales resembled sei whales.

Unidentified Beaked Whales. (Fig. 11, Table 14)

Eight sightings were recorded as beaked whales and six additional sightings are considered probable beaked whales although the shape of the head was not seen. White scarring was noticeable on the head of at least one animal in each pod and this was generally the largest indivdual in the group.

The distribution of beaked whale sightings was different on this cruise than during the January-February Jordan cruise. Earlier this year, beaked whale sightings were more numerous and concentrated near the equator. During this cruise they were seen more often south of the equator and nearer the coast of South America.

Squids

Squids were captured by jigging at 10 stations and by the Universal midwater trawl at five stations. Specimens of the species Dosidicus gigas and Symplectoteuthis oualaniensis were measured, sexed, and indexed for maturity stage. Subsamples were saved for studies of beak identification and gonad development. The distribution of sizes and maturities of these squid were similar to that seen in January-February 1977, i.e., most *Dosidicus* were sexually immature while most *Symplectoteuthis* were mature. The trawl-caught squid included more than a hundred specimens of 50-100 mm ommastrephids. These will be valuable in studies of *Symplectoteuthis*, of which there are apparently two forms.

Birds

Sea bird distributions appeared related to the changed oceanographic regime of the southern winter. Sooty terns (*Sterna fuscata*) were uncommon in the cool waters south of the equator, although they were abundant in the tropical waters to the north. Only west of 105°W was this species numerous in the southern waters (Fig. 12). There were no sightings of white-necked or dark-rumped petrels (*Pterodroma externa* or *phaeopygia*) in the southern waters (Fig. 13). Both the sooty terns and the *Pterodroma* petrels appeared to have moved away from the subtropical waters cooled by the Peru Current. In contrast these birds were abundant along all portions of the January-February 1977 cruise track south of the equator and west of 85°W. Another widespread species, the wedgetailed shearwater (*Puffinus pacificus*, Fig. 14) was seen in the tropical waters north of the equator as well as to the SE of the Galapagos Islands, including off the coast of Peru. In January-February this species was seen only in the equatorial water west of 100°W. The distribution of storm petrels was similar to that of the January-February period. Storm petrels were abundant about the thermocline ridge at 10°-12°N and to the southeast of the Galapagos Islands. Leach's storm petrel (*Oceanodroma leucorhoa*) was the most-common and widespread species. Southeast of the Galapagos Islands the Galapagos storm petrel (*O. tethys*), Hornby's storm petrel (*O. hornbyi*), and Markham's storm petrel (*O. markhami*) were numerous. Frigate birds (*Fregata sp.*, Fig. 15) were widespread, especially north of the equator, and were usually associated with cetaceans. The sightings of porpoise-bird associations, usually involving spotted and spinner dolphins, are described in Figure 16.

Oceanography

The strong sea surface temperature front that develops along the equator during the southern winter was still very much in evidence during October-November (Fig. 17).

- Surface temperatures dropped from 25° to 22°C within the front due to the influence of the intensified Peru Current that extends westward as a cold core of 19°-22°C water. Subtropical waters with salinities greater than 35‰ and a generally weak thermocline at depths greater than 50 m prevailed south of the cold core. In this same area during January-February surface waters, warmed to greater than 25°C, overlay a seasonal thermocline at 30-40 m.

Only four out of 30 sightings of spotted and/or spinner dolphin schools occurred in the cool subtropical waters and these sightings were along the southern border of the cold Peru-S. Equatorial Current (Fig. 17). No Stenella species were sighted west of 100°W. These subtropical waters south and west of the cold-water core were relatively sparse in surface biological activity as compared with the January-February situation. Then Stenella sightings were twice as numerous and there was an abundance of sooty tern flocks. In the area between the Galapagos Islands and Peru, however, the distribution of striped dolphin (S. coeruleoalba), Tursiops, Globicephala, and Grampus were similar in the two seasons, even though cold surface temperatures of less than 22°C prevailed there during this cruise.

In the tropical waters north of the equatorial front the cruise track traversed the region of the Countercurrent. Sightings of Tursiops, Globicephala, and Grampus were relatively infrequent there as compared to the southern waters. The majority of spotted and whitebelly spinner dolphin (S. attenuata and longirostris) sightings occurred in these tropical waters and were most frequently sighted along the northern borders of the front which meandered to 2°-3°N.

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Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 1. Stenella attenuata

Date	Location	Estimated school size	Notes/associated species
10/12/77	11°18'N 109°45'W	300	40% S. longirostris; 70 boobies, white-tailed shearwaters, petrels; tuna
10/12/77	11°00'N 109°40'W	125	80% S. longirostris; 119 boobies, shearwaters, petrels
10/14/77	4°14'N 106°49'W	225	25% S. longirostris; 100 white-tailed shearwaters, sooty terns, frigates
10/14/77	3°12'N 106°32'W	400	65% S. longirostris; 235 sooty terns, white-tailed shearwaters, frigates; fish
10/15/77	3°07'N 104°45'W	70	2 frigates
10/15/77	3°43'N 103°44'W	875	38 sooty terns, frigates, shearwater/petrels
10/18/77	1°39'N 95°40'W	100	20% S. longirostris, 48 frigates, white-tailed shearwaters, boobies, tuna
10/19/77	0°25'N 93°41'W	400	50% S. longirostris, 70 sooty terns, shearwater/petrels, frigates; tuna
10/19	0°22'N 93°34'W	600	10% S. longirostris; 127 sooty terns, boobies, frigates
10/19/77	0°23'N 93°11'W	150	59 sooty terns, boobies, frigates
10/19	0°40'N 92°54'W	200	75% S. longirostris; 128 sooty terns, boobies, frigates; tuna
10/20/77	2°17'N 89°58'W	100	37 boobies, frigates
10/20/77	2°14'N 89°51'W	275	63 terns, boobies, frigates

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 1. (Continued)

Date	Location	Estimated school size	Notes/associated species
10/20/77	2°51'N 89°30'W	100	10% *S. longirostris*; 56 boobies, frigates
10/20/77	2°41'N 89°28'W	125	73 boobies, frigates
10/21/77	0°22'N 87°21'W	75	73 boobies, frigates
10/21/77	0°05'S 87°16'W	15	27 boobies, frigates; tuna
10/22/77	2°50'S 86°05'W	135	70% *S. coeruleoalba*, *Delphinus*; 2 frigates
11/2/77	6°19'S 87°19'W	165	80% *S. longirostris*; 30 storm petrels
11/5/77	3°43'S 97°43'W	345	30% *S. longirostris*
11/7/77	1°30'N 101°52'W	180	2 frigates
11/11/77	0°27'N 112°36'W	330	
11/11/77	0°42'N 112°39'W	1130	
11/12/77	3°08'N 113°19'W	170	
11/18/77	19°21'N 120°40'W	70	

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 2. Stenella longirostris

Date	Location	Estimated school size	Notes/associated species
10/10/77	19°08'N 113°14'W	20	E. spinner; 1 booby
10/10	18°05'N 112°44'W	150	E. spinner
10/12	11°18'N 109°45'W	300	E. spinner, 60% S. attenuata; 70 boobies, white-tailed shearwater, petrels; tuna
10/12	11°00'N 109°40'W	125	E. spinner; 20% S. attenuata; 119 boobies, shearwaters, petrels
10/12	10°49'N 109°38'W	100	E. spinner
10/14	4°14'N 106°49'W	225	75% S. attenuata; 100 white-tailed shearwaters, sooty terns, frigates
10/14	4°00'N 106°48'W	200	46 white-tailed shearwaters, sooty terns, frigates
10/14	3°12'N 106°32'W	400	35% S. attenuata; 235 sooty terns, white-tailed shearwaters, frigates, fish
10/18	1°39'N 95°40'W	100	80% S. attenuata; 48 frigates, white-tailed shearwaters, boobies, tuna
10/19	0°25'N 93°41'W	400	50% S. attenuata; 70 sooty terns, shearwater/petrels, frigates; tuna
10/19	0°22'N 93°34'W	600	90% S. attenuata; 127 sooty terns, boobies, frigates
10/19	0°40'N 92°54'W	200	25% S. attenuata; 128 sooty terns, boobies, frigates; tuna
10/20	2°51'N 89°30'W	100	90% S. attenuata; 56 boobies, frigates
11/2	6°19'S 87°19'W	165	20% S. attenuata; 30 storm petrels
11/3	3°59'S 91°55'W	1100	30 boobies, frigates
11/5	3°43'S 97°43'W	345	70% S. attenuata

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 3. Stenella coeruleoalba

Date	Location	Estimated school size	Notes/associated species
10/15/77	3°49'N 103°34'W	20	
10/16	5°08'N 101°19'W	40	
10/16	6°13'N 99°59'W	100	
10/17	4°08'N 97°10'W	4	
10/20	2°17'N 89°51'W	20	
10/22	2°50'S 86°05'W	135	75% S. attenuata + Delphinus; 2 frigates
10/23	5°13'S 84°47'W	175	
11/2	6°34'S 86°56'W	215	
11/4	3°17'S 94°26'W	130	2 boobies
11/4	2°32'S 94°51'W	290	
11/6	1°33'S 98°59'W	170	
11/6	1°03'S 99°19'W	105	
11/6	1°00'S 99°23'W	65	
11/6	0°28'S 99°41'W	45	

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 4. Delphinus delphis

Date	Location	Estimated school size	Notes/associated species
10/4/77	29°05'N 118°01'W	233	
10/4	28°18'N 118°02'W	75	
10/6	30°52'N 117°03'W	117	
10/6	32°11'N 117°09'W	400	
10/7	31°21'N 117°45'W	50	
10/22	2°50'S 86°05'W	135	55% S. attenuata & S. coeruleoalba; 2 frigates
10/24	7°40'S 82°14'W	1000	
10/24	7°36' 82°12'W	135	
10/24	7°37'S 82°15'W	450	
10/24	7°47'S 82°06'W	250	
11/21	32°15'N 117°24'W	275	

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 5. Grampus griseus

Date	Location	Estimated school size	Notes/associated species
10/22/77	2°38'S 86°06'W	55	75% Peponocephala
10/22	2°42'S 86°06'W	25	
10/23	5°44'S 84°18'W	8	
10/23	5°59'S 84°04'W	14	
10/23	6°02'S 84°01'W	12	
10/23	6°04'S 84°00'W	9	
10/23	6°10'S 83°53'W	5	
10/23	6°22'S 83°40'W	5	
10/23	6°29'S 83°33'W	5	
10/24	7°38'S 82°13'W	4	
10/24	7°39'S 82°14'W	4	
10/31	10°28'S 79°58'W	2	
10/31	10°17'S 80°21'W	2	
10/31	10°04'S 80°44'W	3	
11/1	8°34'S 83°26'W	2	
11/1	8°21'S 83°48'W	5	
11/1	8°14'S 83°59'W	5	
11/2	6°12'S 87°32'W	12	
11/2	6°07'S 87°38'W	15	
11/2	6°00'S 87°47'W	6	
11/2	5°50'S 88°12'W	4	
11/4	2°18'S 94°54'W	2	
11/10	3°22'S 111°47'W	5	
11/11	0°24'N 112°35'W	3	

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 6. Steno bredanensis

Date	Location	Estimated school size	Notes/associated species
11/2/77	5°58'S 87°47'W	22	Globicephala

Table 7. Orsinus orca

10/15/77	3°21'N 104°27'W	3	
11/1	7°51'S 84°44'W	8	
11/12	3°24'N 114°05'W	7	8 frigates

Table 8. Peponocephala electra

10/11/77	15°09'N 111°40'W	15	
10/22	2°38'S 86°06'W	55	14 Grampus
11/4	2°34'S 94°48'W	250	20 Globicephala, 1 Parkinson's petrel

Table 9. Pseudorca crassidens

10/20/77	2°52'N 89°23'W	2	
10/25	9°52'S 79°48'W	60	
11/8	0°24'S 104°34'W	19	

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 10. Tursiops truncatus

Date	Location	Estimated school size	Notes/associated species
10/6/77	30°24'N 117°00'W	4	
10/24	8°03'S 81°44'W	40	
10/24	8°08'S 81°41'W	15	
10/24	8°16'S 81°33'W	40	Birds
10/25	10°21'S 79°12'W	40	Albatrosses; Tursiops milling
10/31	10°28'S 79°58'W	45	5 Globicephala; Tursiops milling
10/31	10°21'S 80°12'W	15	Albatross, boobies, etc.
11/2	6°06'S 87°42'W	30	12 Globicephala
11/2	5°48'S 88°16'W	20	5 Globicephala
11/4	2°42'S 94°44'W	42	29 Globicephala
11/4	2°18'S 94°54'W	2	
11/11	1°01'N 112°46'W	21	18 Globicephala
11/20	29°12'N 118°20'W	47	

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 11. Globicephala sp.

Date	Location	Estimated school size	Notes/associated sp.
10/12/77	10°39'N 109°38'W	10	
10/18	1°11'N 95°28'W	15	
10/22	2°49'S 86°07'W	10	
10/25	10°25'S 78°32'W	3	
10/31	10°28'S 79°58'W	45	40 Tursiops
11/2	6°07'S 87°38'W	15	
11/2	6°06'S 87°42'W	30	18 Tursiops
11/2	5°58'S 87°47'W	22	12 Steno
11/2	5°48'S 88°16'W	20	20 Tursiops
11/4	2°42'S 94°44'W	42	13 Tursiops
11/4	2°34'S 94°48'W	20	
11/4	2°33'S 94°54'W	12	
11/4	2°19'S 94°54'W	12	
11/4	2°17'S 94°55'W	5	
11/4	2°11'S 94°56'W	5	
11/5	3°58'S 96°25'W	12	
11/8	1°19'S 105°50'W	13	
11/10	4°00'S 111°39'W	11	
11/11	1°01'N 112°46'W	21	3 Tursiops

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 12. Unidentified dolphins

Date	Location	Estimated school size	Notes
10/5/77	26°42'N 116°28'W	38	
10/10	18°52'N 113°12'W	12	
10/10	18°41'N 113°03'W	12	
10/10	17°23'N 112°25'W	50	
11/1	8°44'S 83°12'W	1	
11/2	6°22'S 87°12'W	10	
11/2	6°22'S 87°13'W	25	
11/3	4°00'S 91°14'W	100	
11/5	3°28'S 96°02'W	3	
11/6	0°20'S 99°53'W	2	
11/6	0°20'S 99°53'W	1	Globicephala or Grampus?
11/11	0°56'N 112°45'W	1	
11/13	4°36'N 116°06'W	1	
11/13	4°47'N 117°01'W	4	W. Balaenoptera sp.
11/14	6°58'N 117°28'W	10	
11/19	23°39'N 119°40'W	30	

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 13. Physeter catadon

Date	Location	Estimated school size	Notes
10/13	6°14'N 107°40'W	25	Possibly 8 or more calves
10/20	2°33'N 89°53'W	5	
11/2	5°56'S 87°57'W	30	Breaching and splashing seen
11/4	2°09'S 94°57'W	8	
11/8	0°23'S 104°35'W	7	Calf seen
11/8	0°58'S 105°20'W	3	Calf seen
11/8	1°12'S 105°38'W	2	
11/8	1°12'S 105°39'W	1	
11/8	1°15'S 105°46'W	8	
11/8	1°19'S 105°50'W	1	
11/8	1°21'S 105°54'W	8	
11/8	1°29'S 106°01'W	6	Calf seen
11/10	3°49'S 111°41'W	1	
11/10	3°47'S 111°44'W	2	
11/10	3°15'S 111°47'W	1	Approached ship

Table 14. Other whales

Date	Location	Estimated school size	Notes
10/4/77	28°27'N 118°01'W	1	Beaked whale
10/4	28°24'N 118°02'W	2	Beaked whale
10/10	19°20'N 113°24'W	2	
10/10	19°18'N 113°22'W	1	Balaenoptera sp.
10/10	18°38'N 113°03'W	1	
10/10	18°38'N 113°00'W	1	
10/12	10°22'N 109°28'W	4	Beaked whale
10/14	3°37'N 106°43'W	1	
10/14	3°11'N 106°41'W	1	Balaenoptera borealis
10/15	2°54'N 104°55'W	1	Balaenoptera sp.
10/15	3°03'N 104°48'W	1	
10/15	3°08'N 104°43'W	1	Balaenoptera sp.
10/15	3°30'N 104°09'W	1	Balaenoptera sp.
10/16	5°08'N 101°20'W	1	Balaenoptera sp.
10/16	5°08'N 101°15'W	2	Balaenoptera edeni
10/16	5°10'N 101°11'W	1	
10/20	2°29'N 89°56'W	1	Beaked whale
10/21	0°27'N 87°24'W	5	Balaenoptera sp.
10/22	2°31'S 86°05'	1	
10/22	2°55'S 86°01'W	1	
10/23	5°22'S 84°45'W	3	
10/23	6°04'S 84°00'W	3	Beaked whale

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

Table 14. (Continued)

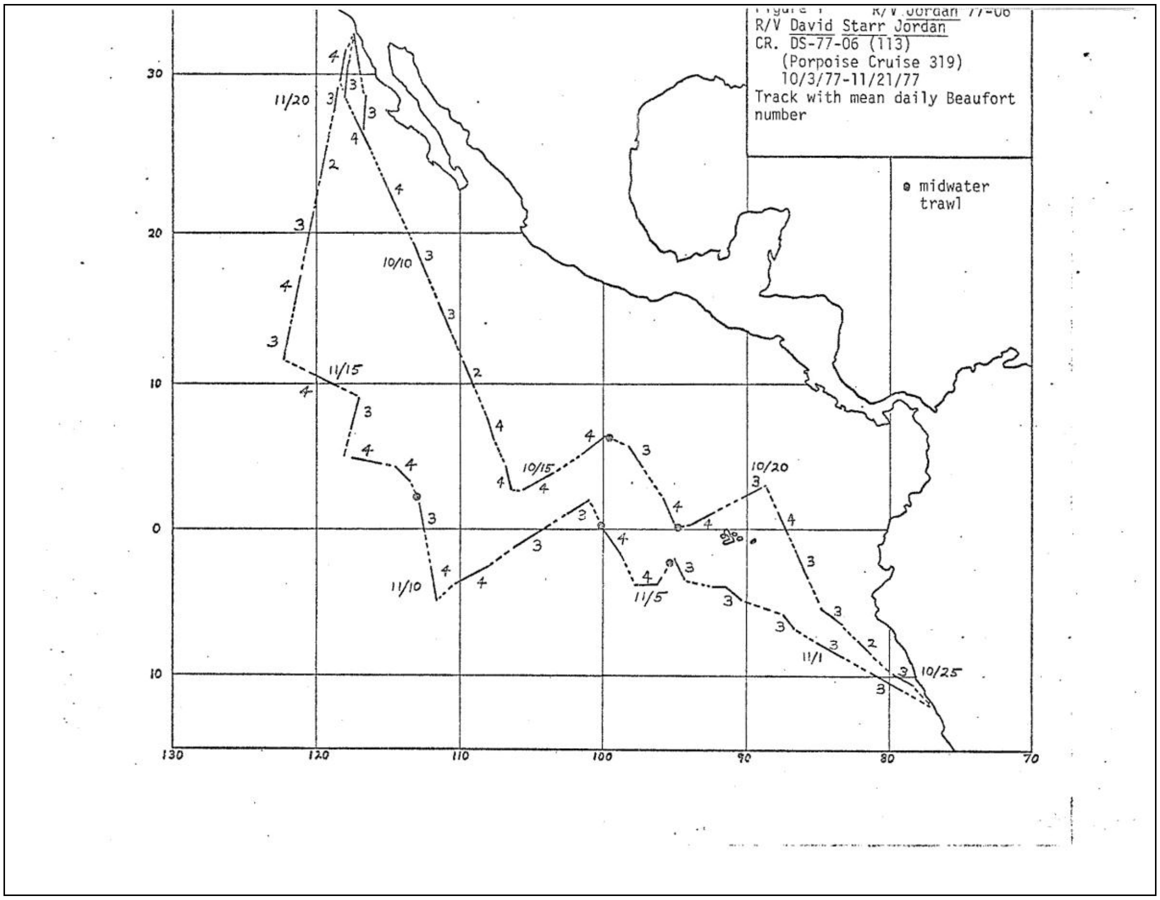
Date	Location	Estimated school size	Notes
10/24	7°44'S 82°10'W	2	
10/24	7°47'S 82°02'W	1	
10/24	7°51'S 81°55'W	5	
10/24	7°55'S 81°52'W	1	Balaenoptera edeni
10/24	8°08'S 81°41'W	3	Beaked whale
10/24	8°19'S 81°29'W	4	Beaked whale
10/31	10°44'S 79°30'W	1	Beaked whale?
11/1	8°38'S 83°22°W	1	Balaenoptera sp.
11/1	8°37'S 83°23'W	1	
11/1	8°19'S 83°50'W	1	
11/2	6°23'S 87°09'W	2	
11/2	6°19'S 87°14'W	2	
11/2	5°48'S 88°15'W	2	Beaked whale?
11/3	4°10'S 90°59'W	1	Beaked whale?
11/3	4°05'S 91°08'W	1	Balaenoptera sp.
11/3	3°58'S 91°28'W	1	Balaenoptera sp.
11/4	3°37'S 94°11'W	2	Balaenoptera sp.
11/4	2°39'S 94°46'W	3	Beaked whale?
11/5	3°58'S 96°29'W	2	Beaked whale
11/6	0°33'S 99°39'W	1	
11/6	0°20'S 99°53'W	1	
11/7	1°20'N 102°03'W	1	

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

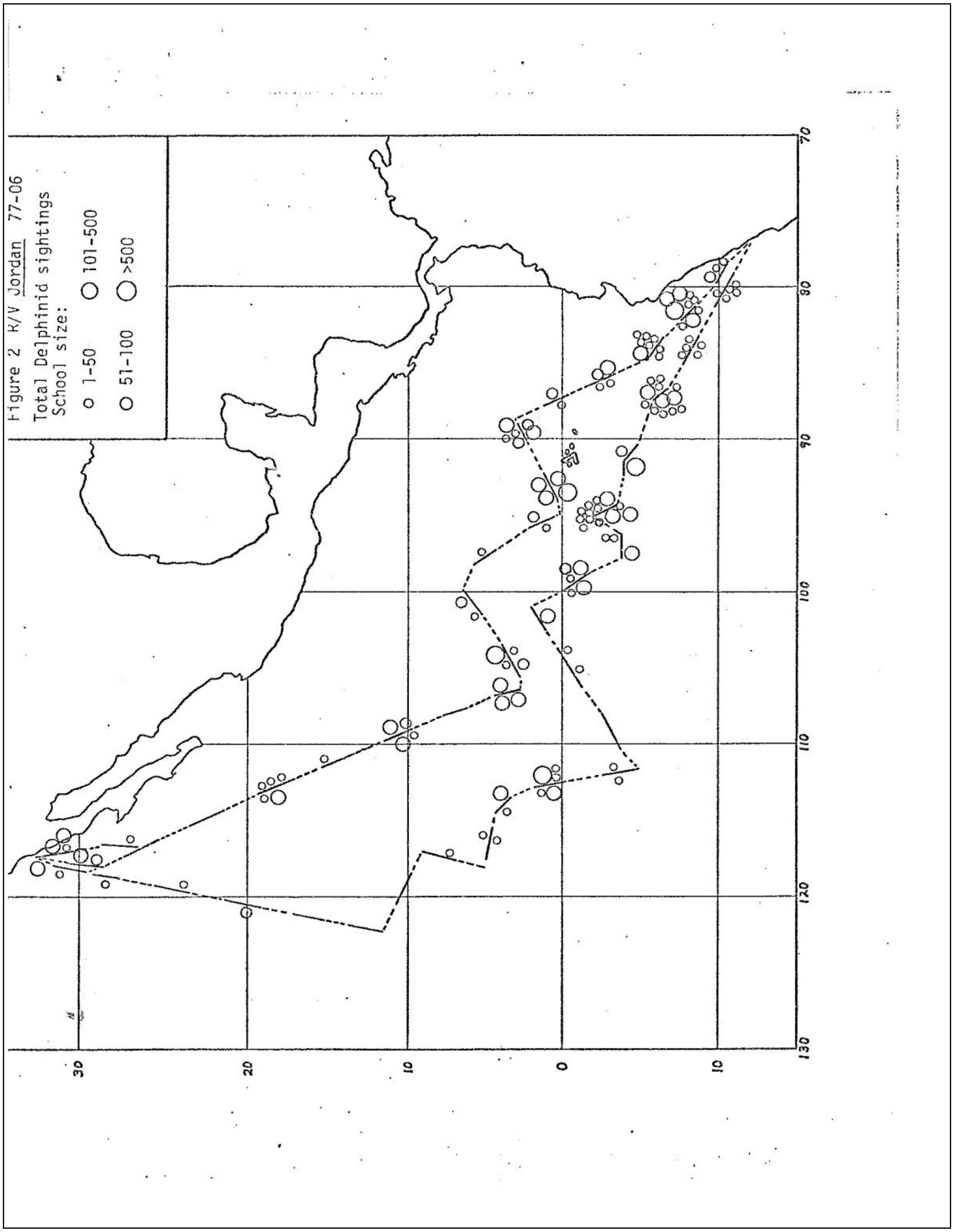
Table 14. (Continued)

Date	Location	Estimated school size	Notes
11/7	1°18'N 102°05'W	1	
11/7	1°18'N 102°05'W		
11/7	1°18'N 102°05'W	1	*Balaenoptera* sp.
11/10	3°24'S 111°47'W	1	Beaked whale?
11/11	1°24'N 112°50'W	1	*Balaenoptera* sp.
11/13	4°47'N 117°01'W	4	*Balaenoptera* sp.
11/17	15°16'N 121°33'W	1	
11/17	16°03'N 121°23'W	1	*Balaenoptera* sp.
11/17	16°51'N 121°15'W	1	*Balaenoptera* sp.
11/19	25°16'N 119°16'W	1	Beaked whale?

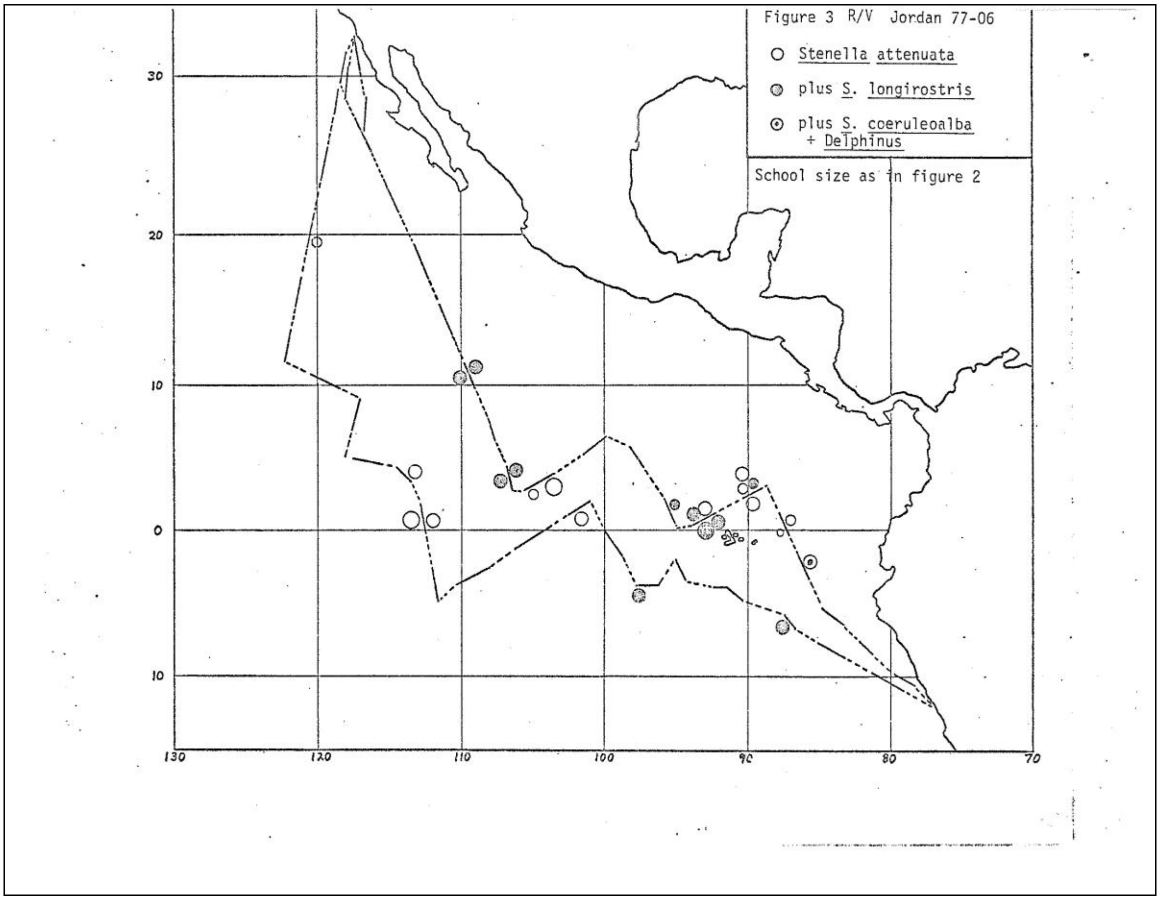
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



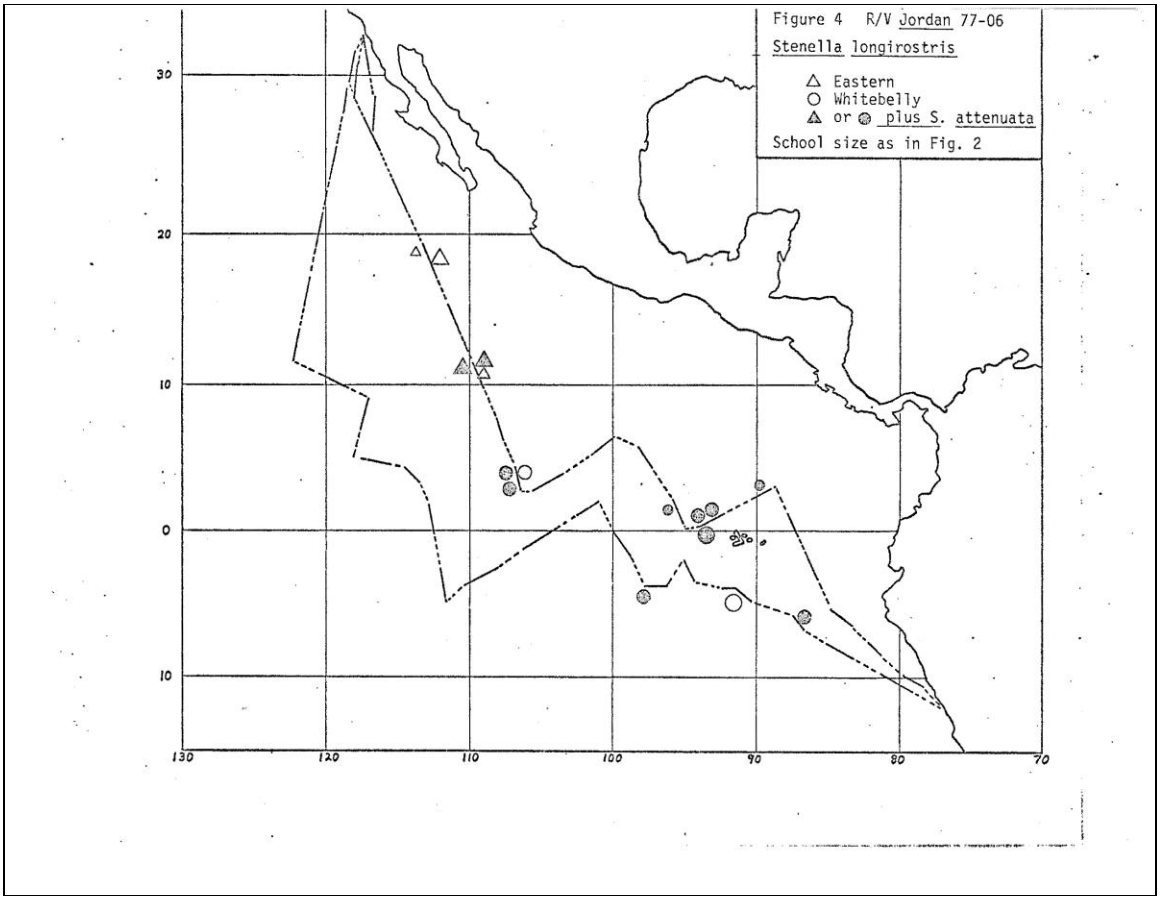
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



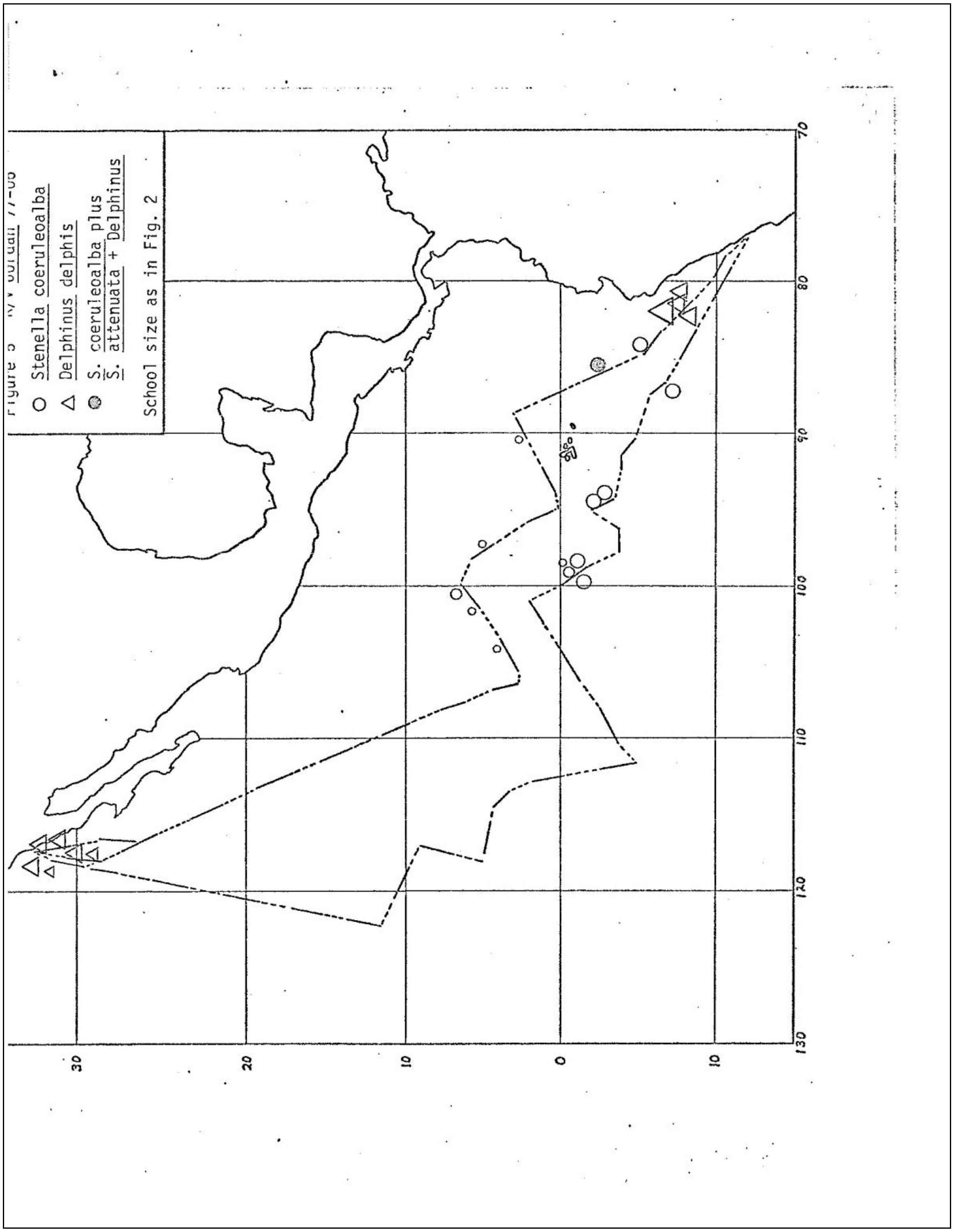
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



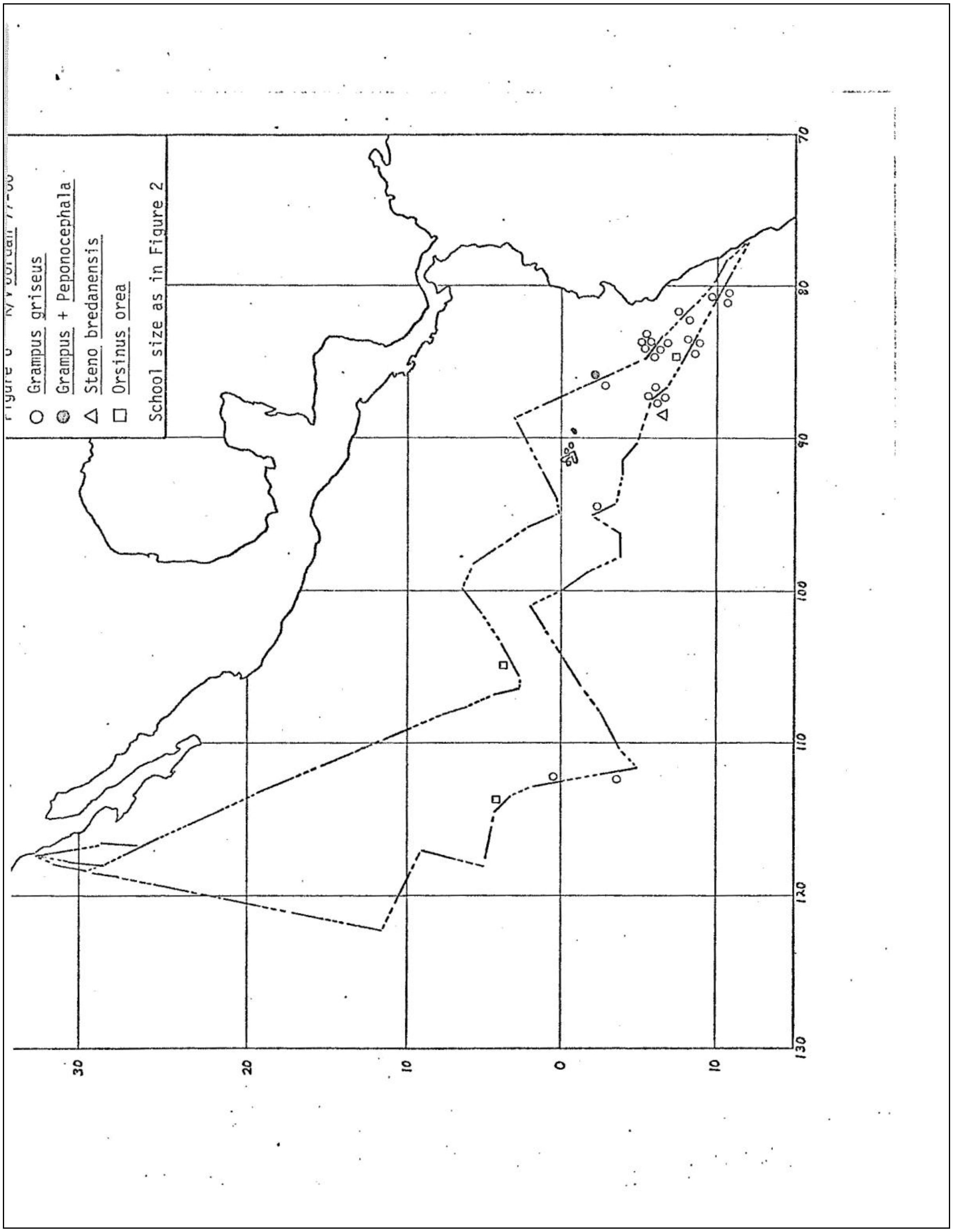
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



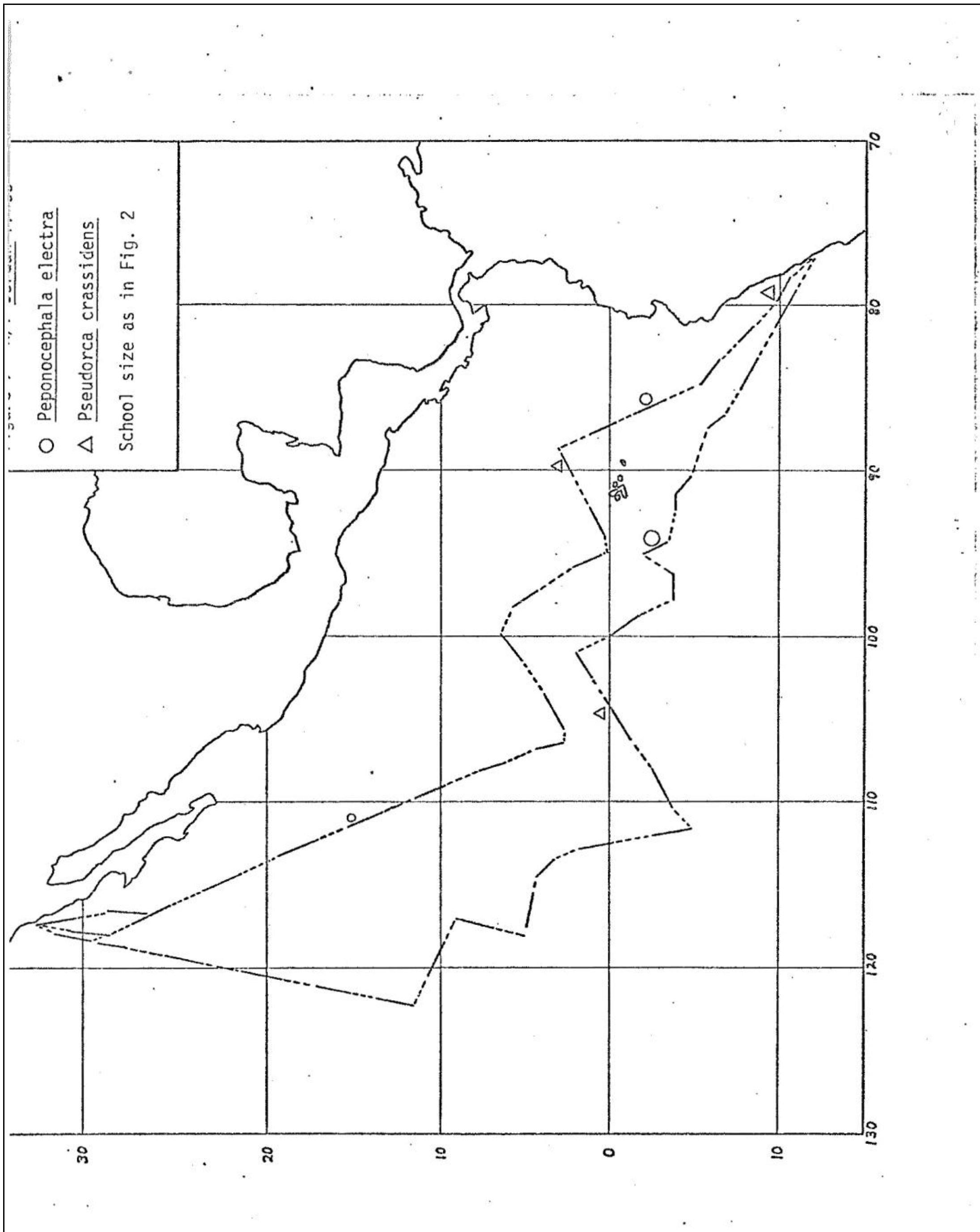
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



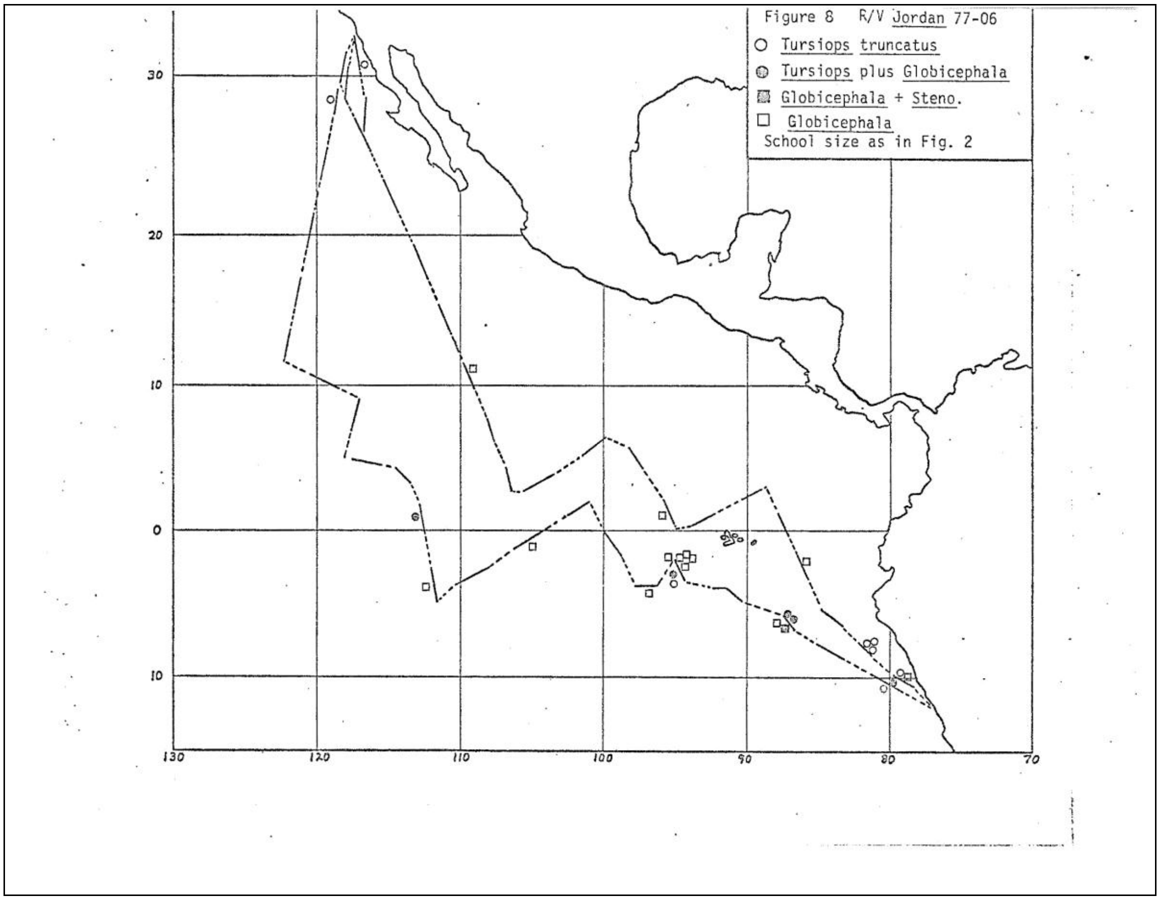
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



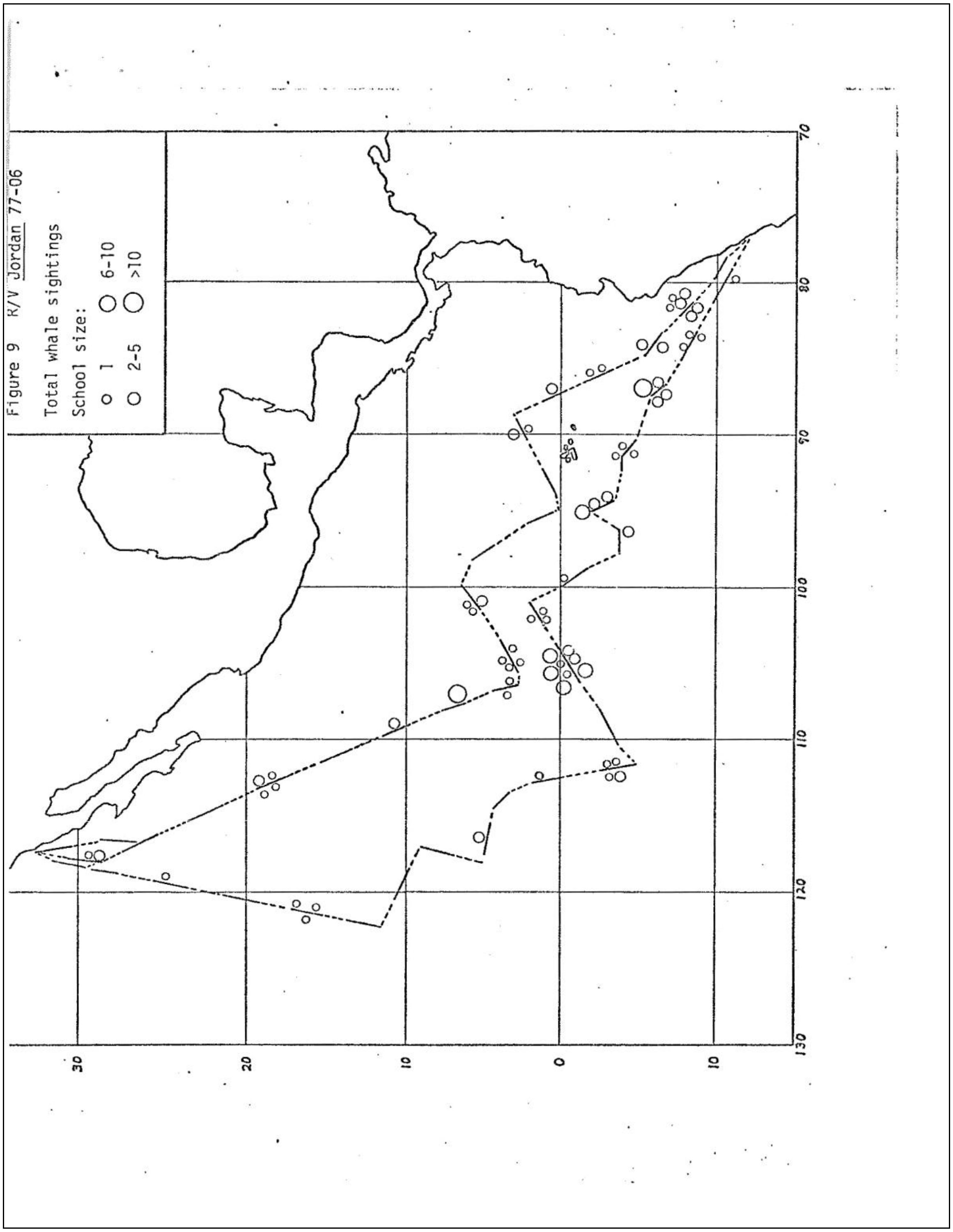
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



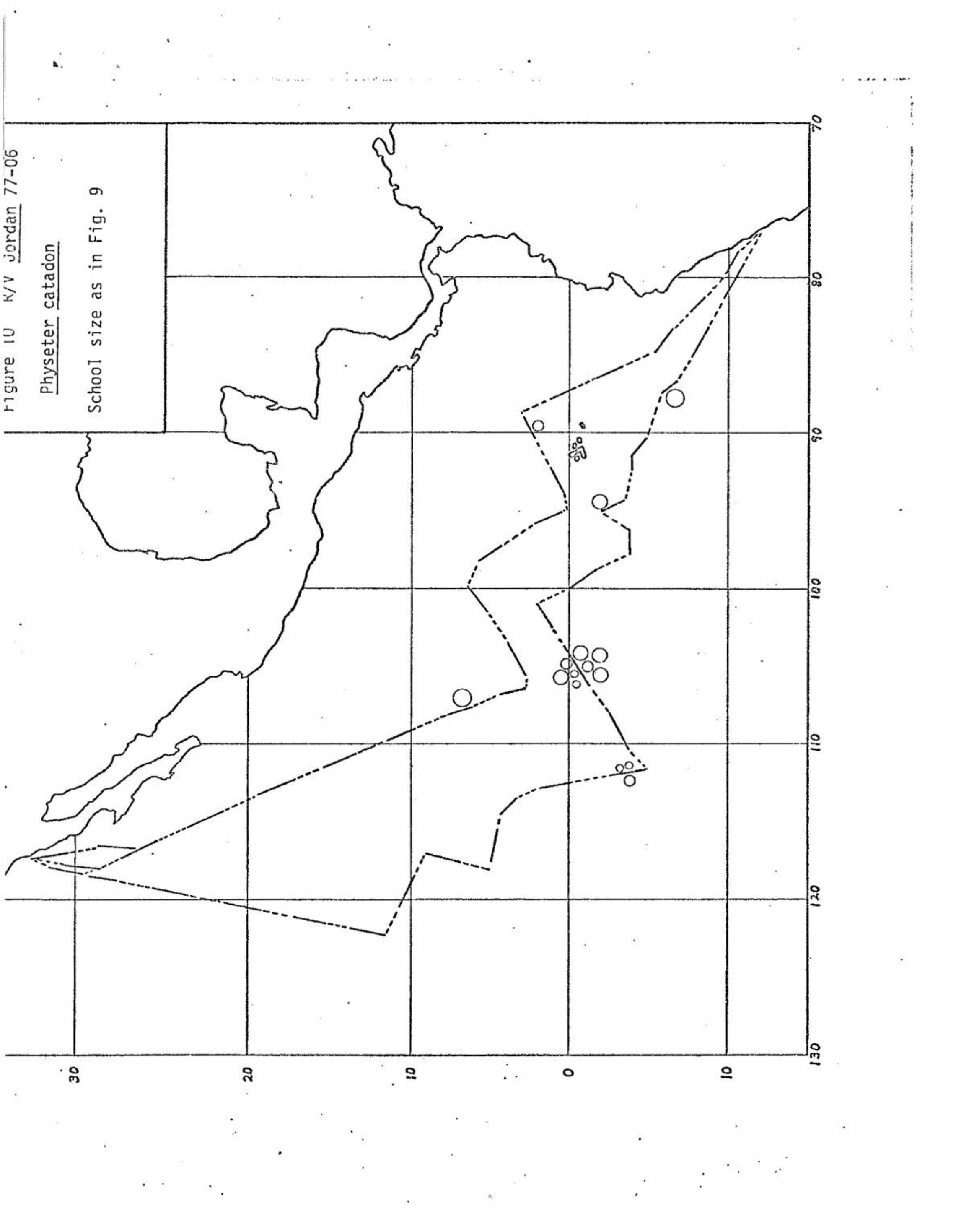
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



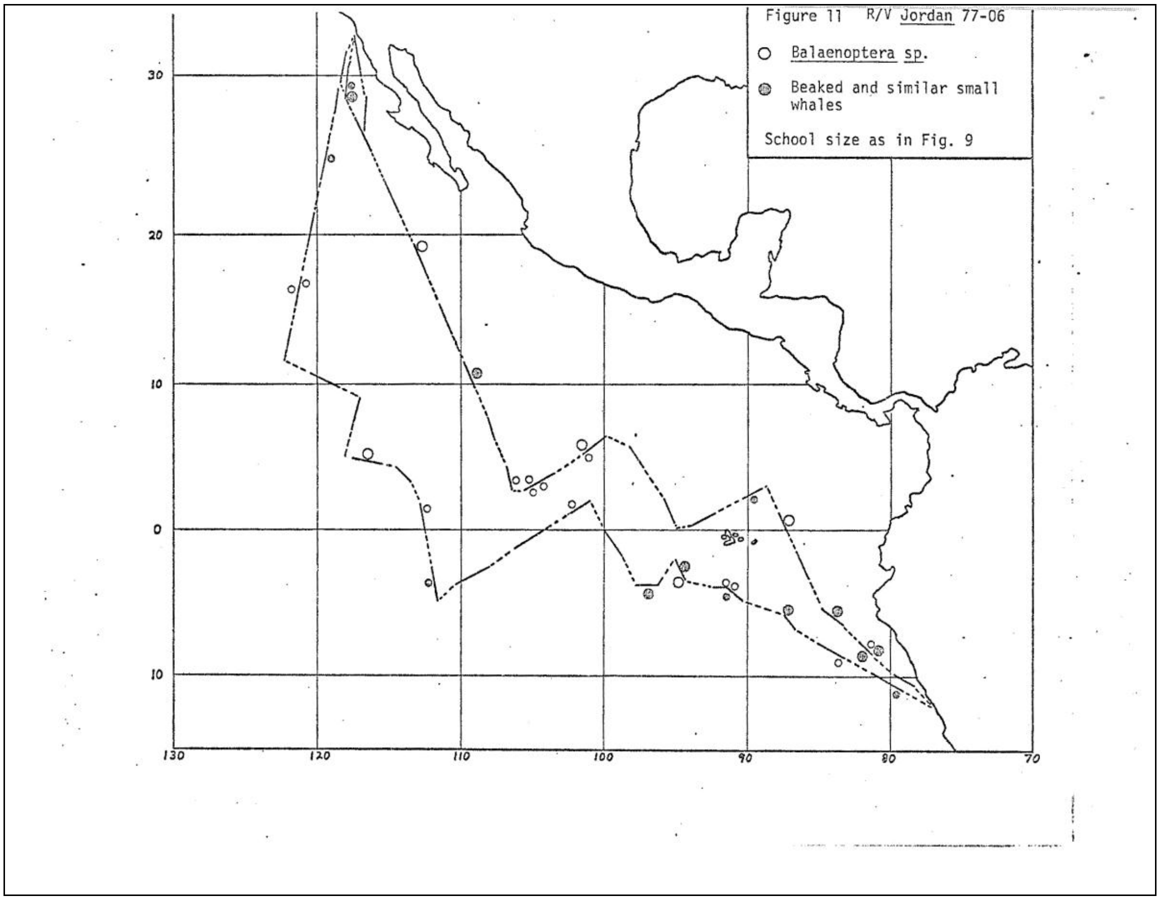
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



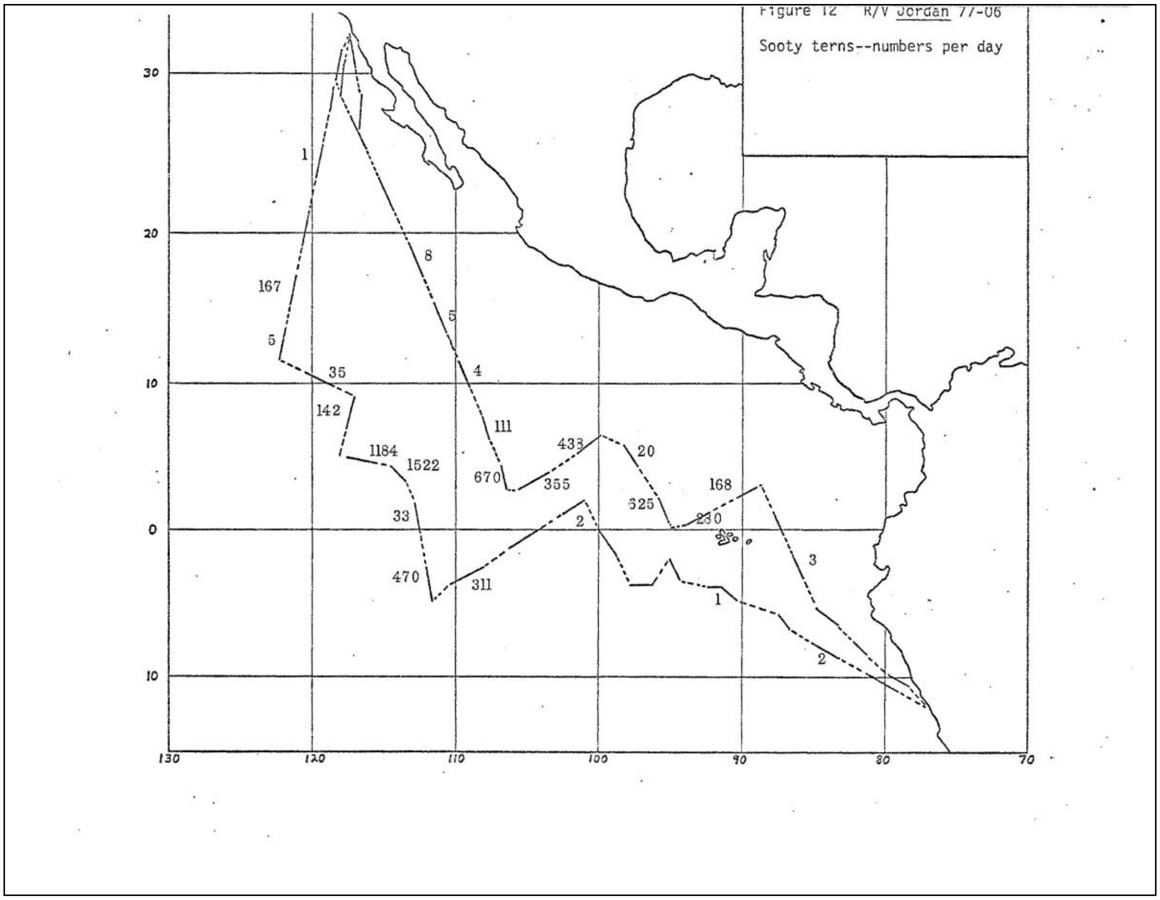
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



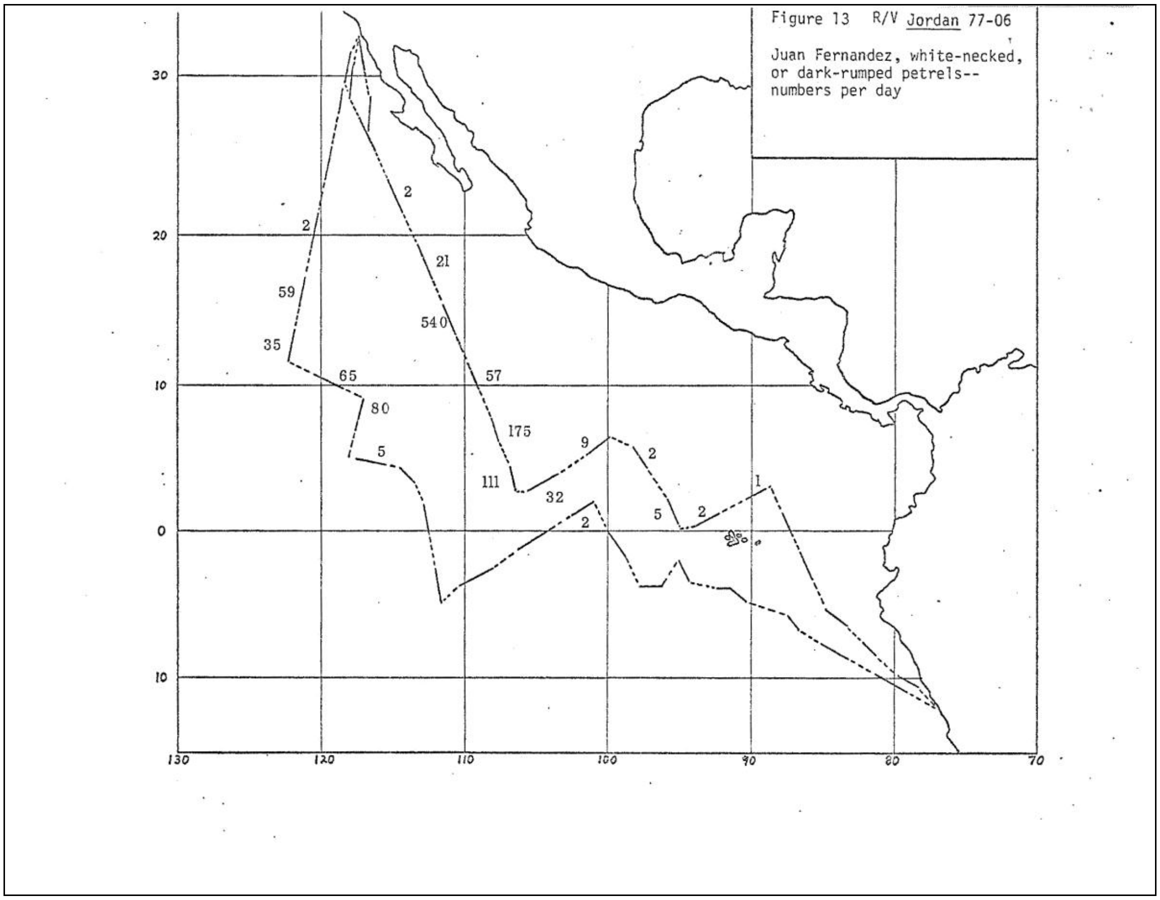
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



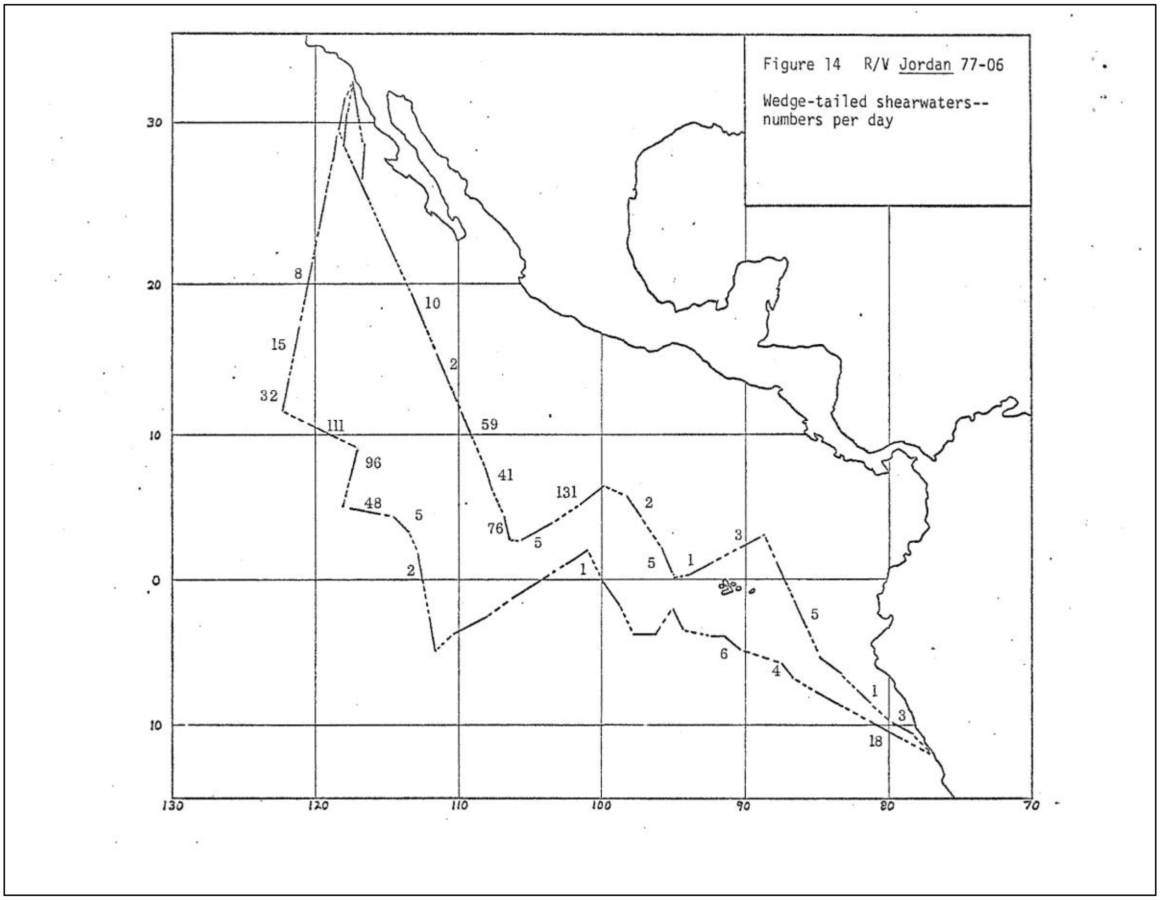
Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)

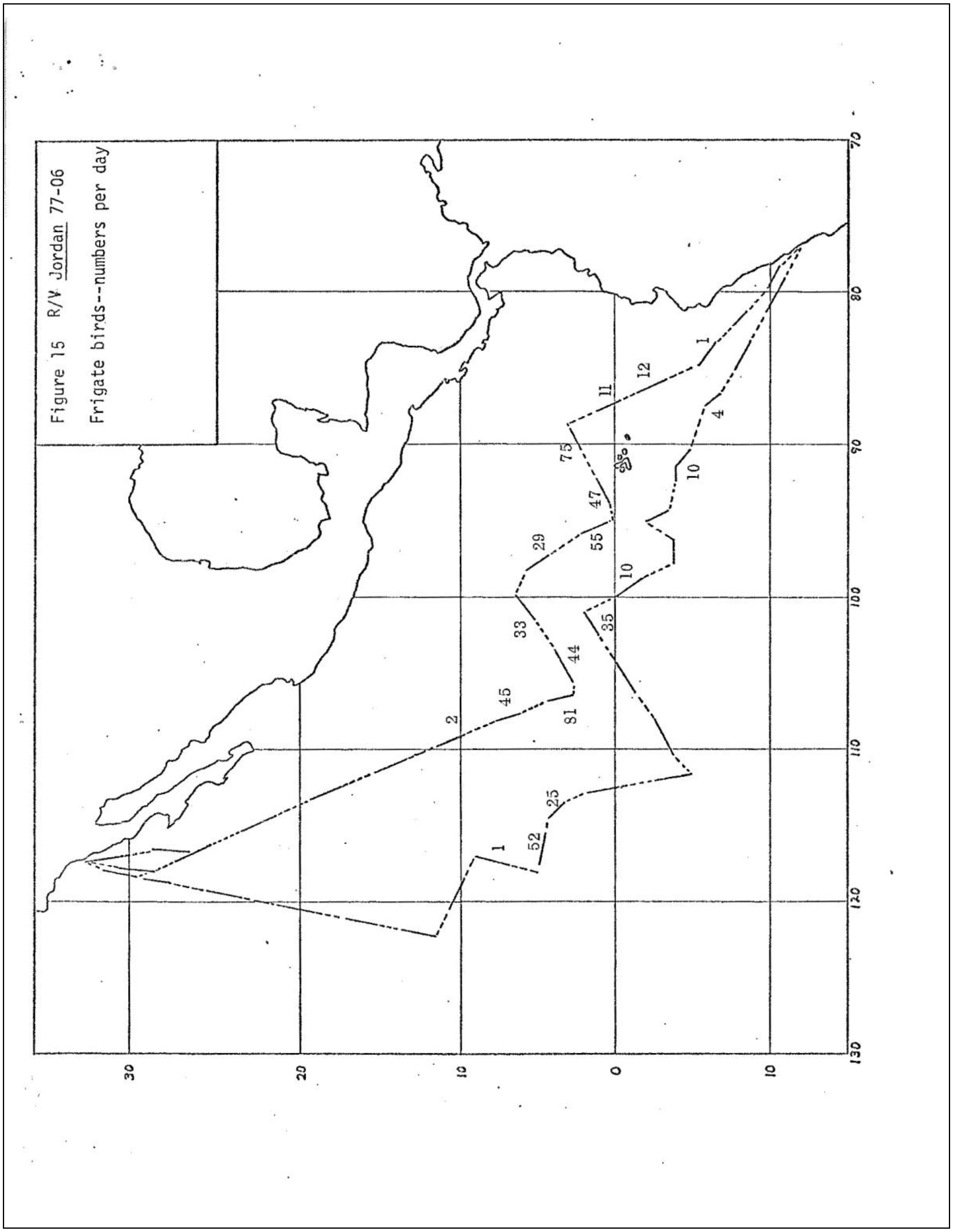
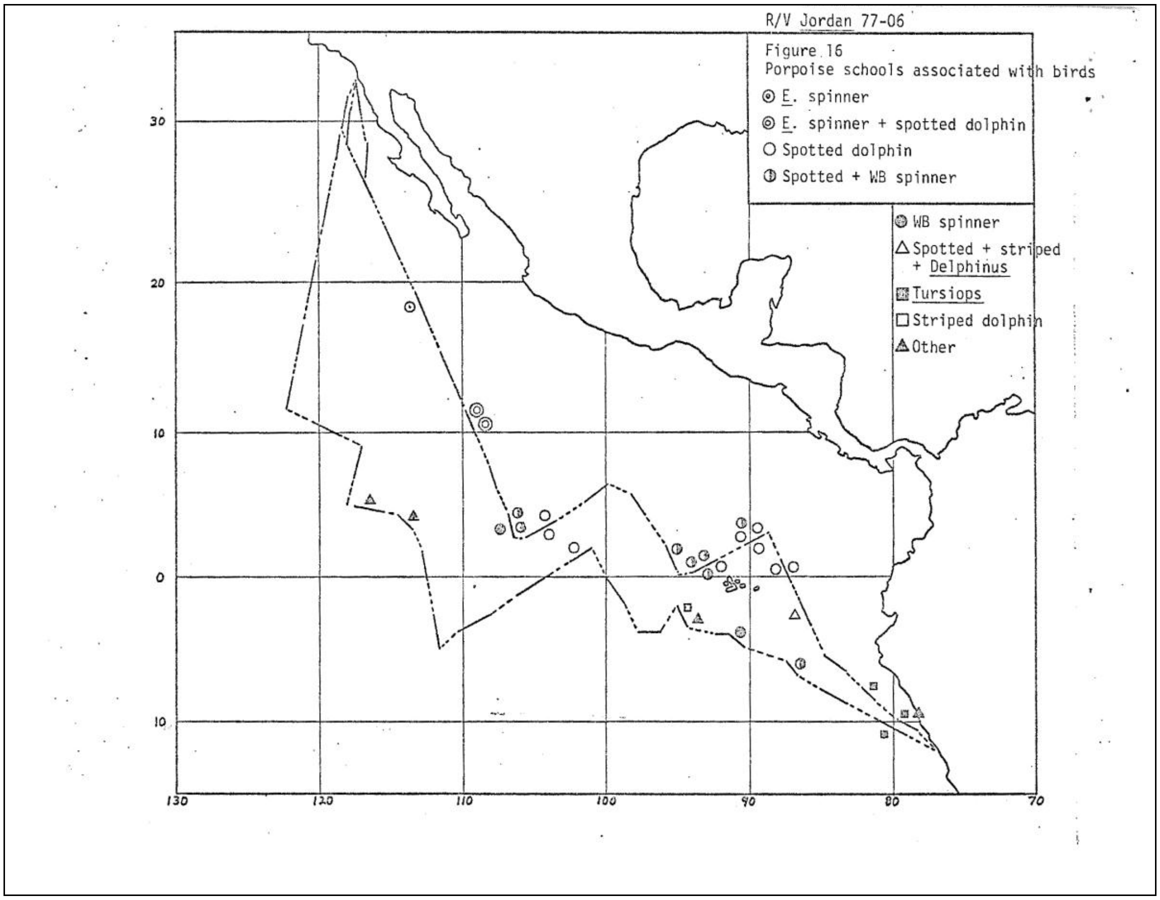
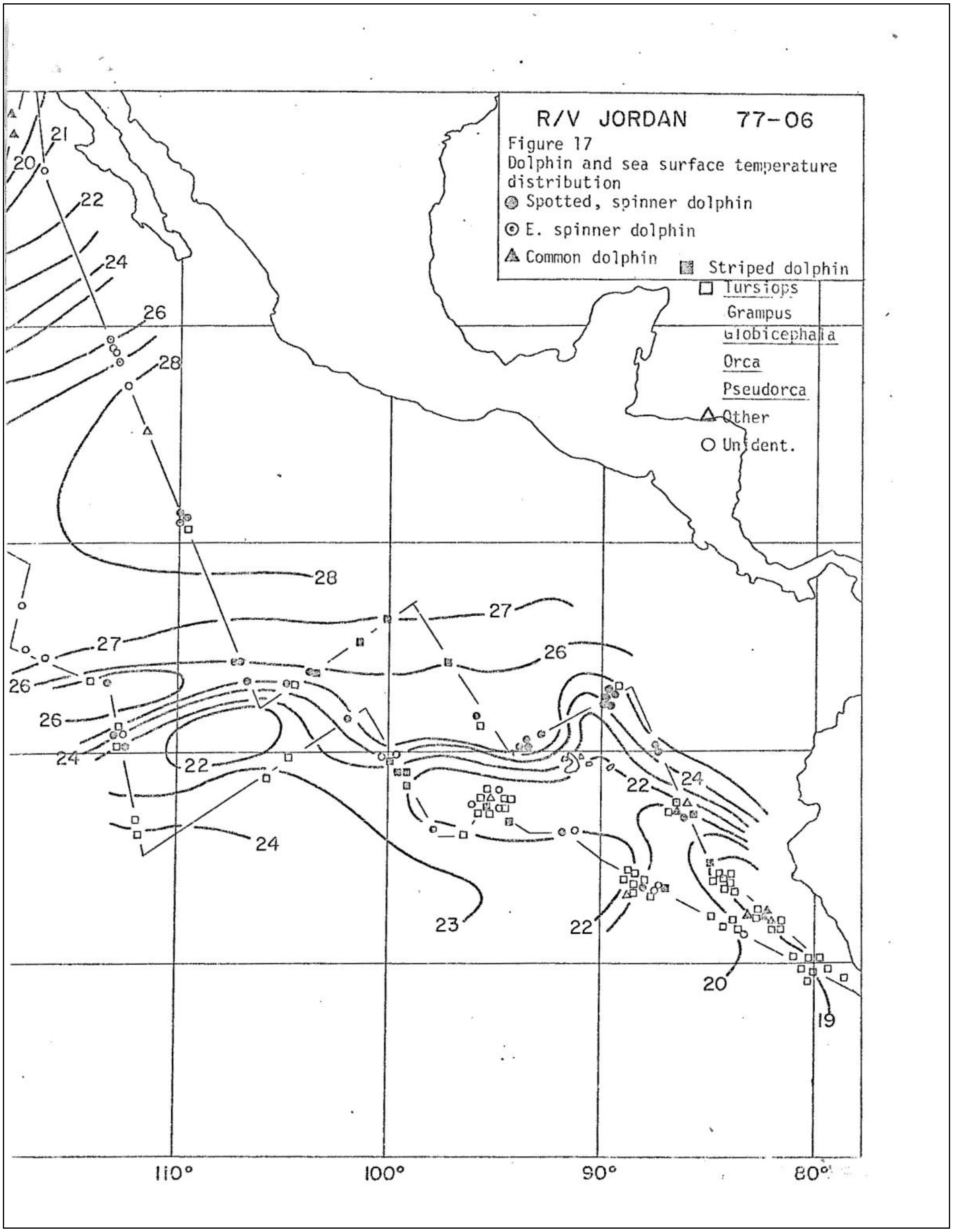


Figure 15 R/V Jordan 77-06
Frigate birds--numbers per day

Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



Appendix 2M. Cruise report for SWFSC Cruise 0319. (Continued)



Appendix 2N. Cruise report for SWFSC Cruise 0428.

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U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Marine Fisheries Service
SOUTHWEST FISHERIES CENTER
La Jolla, California 92038

REPORT OF THE PORPOISE BEHAVIOR CRUISE

R/V REGINA MARIS

CRUISE #428

VESSEL AND EQUIPMENT: The R/V *Regina Maris* built in 1908 is a three masted barquentine owned and operated by the Oceanic Research and Education Society, Boston, Massachusetts (Dr. George Nichols, Jr., Master). She has the capability of running silently (under sail and battery power alone) for 24 hours. The vessel is 103' in length at the water line and has a beam of 26', and a draft of 12'. The main source of power other than sails is a 350 H.P. diesel (GM). The *Regina Maris* averaged approximately 5 knots during this cruise, using various combinations of sail and diesel power.

CRUISE PERIOD: August 1, 1978 to September 30, 1978

AREA OF OPERATION: The *Regina Maris* was chartered for a 30-day period to operate within the porpoise/tuna fishing grounds. Areas of operation during this period of the cruise roughly included areas north of the Galapagos Islands to the Costa Rican coast. (See cruise track for more detailed information.)

OBJECTIVES: The primary objective was to study the behavior of undisturbed porpoise schools. The use of a sailing vessel as an observation platform eliminates engine noise as one source of disturbance to these porpoises. Porpoises in the study area normally run away from motor-driven vessels.

RESULTS: The cruise lasted approximately 60 days, of which 30 days were chartered for porpoise behavior research. Marine mammal sightings were made on an opportunistic basis during the unchartered period (~29 days). This period was spent primarily in and around the Galapagos Islands. This area is not typically part of the fishing grounds. The Galapagos Islands' marine environment, influenced by cold water currents, is apparently rarely frequented by the tropical Stenella attenuata and Stenella longirostris species.

Galapagos marine mammal sightings included numerous Tursiops truncatus schools, pods of Physeter catodon and Globicephala macrorhynchus, Orcinus orca, Delphinus delphis, Stenella coeruleoalba and numerous unidentified rorquals. Sealions were also quite numerous. Each island seemed to have its own Tursiops school, with some schools having fairly distinct colorations or color patterns. Feeding concentrations of mixed Tursiops, sealions and local birds were observed on several occasions.

Observations on the Fishing Grounds:

August 29 marked the beginning of the concentrated search for S. attenuata and S. longirostris schools. The vessel headed north for warmer waters and tuna/porpoise schools. Sighting conditions for this period averaged fair to poor. Wind (in excess of 15 knots) gave us constant problems, and, though sailing conditions were good, the wind chop cut visibility and searching significantly. There was also a great deal of rain throughout this period.

Schools of cetaceans sighted included S. attenuata, S. longirostris, S. coeruleoalba, D. delphis, and T. truncatus. Pods of G. macrorhynchus, Pseudorca crassidens, P. catodon, Grampus griseus and numerous unidentified small whales were also logged.

Sighting #1 Stenella longirostris (whitebelly spinner) Sighted 8/31/78, 1610 hours. This school was sighted about 4 miles away, birds (red footed boobies and frigate birds) being the sighting cue. The school was approached under sail with neither the main nor auxiliary engines running. At 1650 hours, a few animals with sharply falcate dorsal fins (spotters?) crossed the bow - the majority of this school (whitebelly spinners) stayed about 100 yds to port, jogging upwind. These animals approached the vessel in a somewhat scattered school. They apparently lost interest and moved off slowly. Sailing progress was halted as we drifted to observe the school. The spotters were not seen again, but the whitebelly spinners remained undisturbed in a fairly tight school. Characteristic spinning behavior was observed. Wind forces gradually moved the vessel out of reasonable sighting range. The animals were last observed 500 yards off the stern. (1740 hours - 2°12'N/92°44'W).

We headed northeast of this area in the general direction of Cocos Island as far as 5°N and east to the 87°W (9/6/78). We encountered Steno bredanensis, P. crassidens, G. griseus, T. truncatus, and unidentified small whales in this area. Sighting conditions continued unfavorable (wind 15-20 knots and rain nearly everyday), so it was decided to move south, searching for slightly cooler water and perhaps less wind. On 10 September 1978 at approximately 2°N/86°W, the wind finally lessened and water temperature dropped below 80°F. P. catodon, S. coeruleoalba, and one unidentified porpoise school were observed. The unidentified school was our first encounter with a school we were unable to catch up with. Bird signs were favorable, porpoises were sighted, but it proved impossible to catch this moving school (vessel speed 3-4 knots, school speed estimated 4-6 knots).

The return to 5°N/85°W was uneventful, as only S. coeruleoalba and T. truncatus were spotted. From the Cocos Island area to coastal Costa Rica (9/18/78 - 9/24/78), sighting frequency improved, especially in the calm coastal Costa Rican waters. A spotter school on 9/18/78 was another discouragement. The school was moving upwind to starboard, and to follow them meant to motor. Upon starting the engine, the school started running and then slowed. We were unable to keep up with this school (vessel speed ~5 knots).

Cocos Island to Costa Rica - We encountered P. catodon, G. griseus, T. truncatus, G. macrorhynchus, numerous coastal S. attenuata schools and unidentified large and small whales.

The final week was spent along the Costa Rican coast (the area roughly from the Gulf of Papagayo to the Nicaraguan border). This area was the best as far as weather and abundance of cetaceans encountered. Though there wasn't enough wind to permit approaching schools under sail, the Costa Rican coastal spotters were unaffected by vessel noise (engine, etc.).

Animals or schools we encountered included *S. attenuata*, *D. delphis*, *G. griseus*, *T. truncatus*, and numerous unidentified small whales. On September 27, 1978 at 1300 hours, we discovered a large coastal spotter school. The school was inactive and scattered over several square miles. It consisted of numerous subgroups of up to 20 animals. Our best estimate was 500 animals total. Several passes were made through various subgroups, and though the animals were clearly visible (bowriding and responding to the vessel's presence), undisturbed subgroups remained just out of observation range. Observed behavior thus consisted of animals responding to our presence. Distant observable behavior included typical lobtailing, leaping, side slapping, etc. Bowriding animals and subgroups close to the vessel occasionally displayed acts of chasing or aggression. One animal was seen pushing a small piece of driftwood with its dorsal fin. Several mother-calf pairs were seen with this school and at one point, a group of 6 animals (3 mother-calf pairs) were bowriding. Observations of this school ended at 1600 hours. The following day we encountered similar schools and subgroups (*S. attenuata* - Gulf of Papagayo). During sighting periods, subgroups of 10+ animals would come in and bowride. Others at the same time would keep their distance. Observation or sighting periods lasted an hour or more on these scattered coastal spotter schools.

Directional Hydrophone

The directional hydrophone loaned to NMFS by the Oceanic Research and Educational Society was tested briefly August 30, 1978. We were unable to hear the large school of *Tursiops* around the vessel even though they were making sounds audible to the ear at the surface. Problems in mounting the hydrophone existed in that the only reasonable place to mount it limited directional listening to 150^0 (scan - portside). Plans to use the hydrophone to monitor and stay with a school at night were abandoned.

Photography

Photos taken have been of value in documenting sightings, post-cruise identifications and as a record of observed behavior.

Environmental Data

Weather data and XBTs were taken on a regular basis. These data may be of value when correlated or examined in conjunction with sighting information.

Conclusions

The major problem encountered during this trip was weather. The high winds severely limited the sightability of porpoise schools. The several observations of porpoise schools that were successful provided some worthwhile data.

The school of whitebelly spinners displayed a great deal of spinning behavior. While spinning is a normal part of the behavioral repertoire of these animals, being chased and captured by a tuna-seiner appears to repress this behavior pattern. Furthermore, the spinners approached the Regina Maris, which was under sail at the time, suggesting that engine noise may be the cue used by porpoise in evading capture during fishing operations. Some further evidence for this came later in the trip, when after making an approach to a school of spotters while we were under sail, it was necessary to start the engine to follow the animals as they were moving upwind. Immediately after the engine started, the entire school leaped out of the water and began running away from us, upwind. The school was at least ¼ mile from the Regina Maris when the engine was started.

Another set of observations that may be of some value concerns a school of Delphinus that was associated with tuna and birds. During approximately one hour of observation on this school, the following series of behavior patterns were noted repeatedly.

The birds would begin to break up and decrease the frequency of their feeding dives. Many birds would land on the water and drift quietly. During this period, the porpoises would mill about with frequent leaps and a lot of splashing. No tuna could be seen during these periods.

Suddenly the tuna would reappear at the surface, cutting rapidly through the water with the dorsal fin often exposed. Simultaneously, the birds would all become airborne and make dive after dive or in many instances they would follow a tuna shooting along near the surface. The porpoise would also enter the tuna school, and they appeared to be feeding. Finally, the tuna would disappear again and the birds and porpoise would go back to their quiet behavior.

On several occasions, the tuna moved away from the drifting birds and the porpoise. On each occasion, they would reappear at the surface within 100 to 200 meters, and the birds and porpoise would follow. During the entire period of observation, the tuna were obviously leading the porpoise school. The front of the porpoise school was often 25 to 100 meters behind the visible part of the tuna school.

The coastal spotter schools also provided some interesting observations. Each of these schools were widely scattered. The schools were composed of quite tightly associated (i.e. 0-10 body lengths interanimal distance) groups composed of 5 to 15 animals. Thus, there were small clumps of animals separated from other groups by 100's of meters. The entire school probably covered an area of 5 to 20 square miles. When the vessel would approach (under power) to within ¼ mile or less of a group, the animals would begin to move slowly so as to end up in the path of the ship. Each group would then spend several minutes riding the bow or just remain with the vessel. Aggression was common during periods when animals were bowriding.

SUMMARY: This cruise was designed to test the feasibility of using a sailing vessel for the study of porpoise behavior. The use of a sailing vessel eliminates the problem of engine noise and allows one to approach a porpoise herd. Once the approach has been made, however, two difficulties present themselves. The first is that the porpoise frequently move upwind making it impossible for a sail powered vessel to stay with the porpoise. The second problem concerns the size of porpoise schools in terms of the area covered. Many of the schools observed on this trip were spread out over a very large area and even when we went aloft in the rigging, we could see only a small percentage of the school at any one time. This limits greatly the features of behavior that can be observed and makes the sailing vessel a second best platform for behavior studies. This is unfortunate because the charter costs for a sailing vessel are much less than will be required to obtain the services of a helicopter-equipped tuna-seiner for the same kind of research.

Date: 5 Dec 78 Prepared by: Warren E. Stuntz for
Thomas B. Shay

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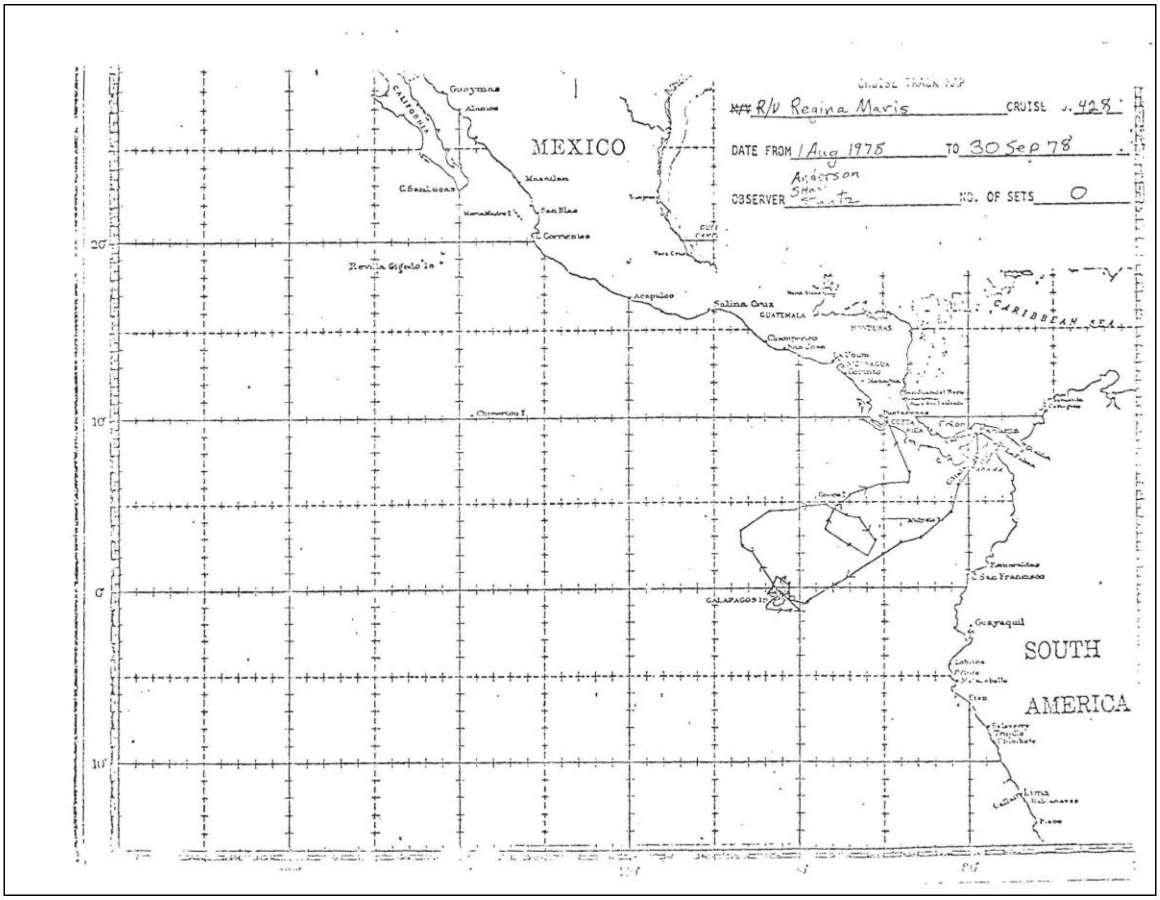
Date: 12/7/78 Approved by: Izadore Barrett
Izadore Barrett
Center Director

Appendix 2N. Cruise report for SWFSC Cruise 0428. (Continued)



Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464.

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Marine Fisheries Service
SOUTHWEST FISHERIES CENTER
La Jolla, California 92038

REPORT OF THE PORPOISE SURVEY CRUISES

R/V David Starr Jordan

Townsend Cromwell

PROJECT: Porpoise Population Assessment Survey

VESSELS: *R/V David Starr Jordan,* Cruise DS 79-1 (Porpoise Cruise 463)

R/V Townsend Cromwell, Cruise TC 79-1 (Porpoise Cruise 464)

CRUISE PERIOD: January 3 - March 16, 1979

ITINERARY:

1. *David Starr Jordan:*

January 3, 1979	Depart San Diego
January 23, 1979	Arrive Cocos Island
January 24, 1979	Depart Cocos Island
January 26, 1979	Arrive Puntarenas, Costa Rica
January 29, 1979	Depart Puntarenas
February 17, 1979	Arrive Acapulco, Mexico
February 17, 1979	Depart Acapulco
February 27, 1979	Arrive Manzanillo, Mexico
March 2, 1979	Depart Manzanillo
March 10, 1979	Arrive San Diego

2. *Townsend Cromwell:*

January 3, 1979	Depart Honolulu
January 25, 1979	Arrive Puntarenas, Costa Rica
January 29, 1979	Depart Puntarenas
February 27, 1979	Arrive Manzanillo, Mexico
March 2, 1979	Depart Manzanillo
March 16, 1979	Arrive Honolulu

OBJECTIVES: To accomplish a calibration study off southern Mexico and Central America, comparing measurements of dolphin (porpoise) density from two ships and a PBY aircraft surveying the same area.

To study and compare dolphin school structure and behavior in different portions of their ranges, including areas outside the calibration study area.

To study the differentiation of species or subspecies of dolphins, especially in boundary regions of major stock ranges.

To study trophic interactions involved in dolphin-seabird-fish associations, comparing among different areas of habitat.

To study effects of environmental conditions on dolphin densities.

To study the variance of dolphin school size estimates among different observers.

To obtain measurements of swimming speed differences among the different dolphin species.

To obtain certain biological specimens (species of squid, seabirds, and *Halobates*) for study.

To assist FGGE personnel to obtain meteorological soundings.

To obtain hydrographic measurements along the equator in support of NORPAX studies.

OPERATIONS: The *R/V's D. S. Jordan* and *T. Cromwell* cruised approximately 12,600 and 13,400 track miles respectively (Figure 1). A 12-hour marine mammal watch was maintained daily, generally beginning at 0600 and ending at 1800 hours, LMT. The ships searched approximately 5,840 and 6,460 total miles respectively, averaging about 103 search miles per day. Vessel speeds were between 9 and 10.5 knots, except in very rough seas.

The marine mammal search utilized 25x150 mm Fuji binoculars aboard the *D. S. Jordan* and 20x120 mm USN MK-3 binoculars aboard *T. Cromwell*. A pair of these binoculars was mounted port and starboard on the flying bridge aboard *D. S. Jordan* and on the bridge wings aboard *T. Cromwell*.

The distance to the horizon from these positions was approximately 7 and 5.5 miles respectively from each vessel. The observers stood 3-hour watches, interchanging positions port and starboard hourly. Upon sighting a marine mammal school, the ship was usually directed to approach the school closely for identification, photography, school size counts, and behavioral observations. At the conclusion of the observation, the ship would return to its predetermined course.

Hydrographic measurements consisted of expendable bathythermograph (XBT) drops and monitoring of the sea surface. XBT's were dropped at 6-hour intervals each day (0600, 1200, 1800, 000 hours) except along the equator where they were dropped at 3-hour intervals from the *T. Cromwell*. This was to generate a temperature section from 125°W to 100°W for comparison with a similar equatorial section between 140°E and 158°W obtained during February 1979 by NORPAX scientists. These two sections will be examined by the NORPAX group at S.I.O. in studies of the equatorial currents. There was insufficient time for the *T. Cromwell* to take other hydrographic measurements along the equator. However, a careful record was kept of ship drift, comparing dead reckoned and satellite-fixed positions. The thermo-salinograph recorder was annotated with each XBT drop, and a salinity sample taken daily. XBT surface temperatures were checked against the surface thermograph trace and bucket temperatures. XBT's were not dropped within 200 miles of the Mexican or Central American coasts.

A bird sighting log, flying fish log, and an hourly watch log were maintained each day. The latter log served to record weather and sightability conditions affecting searching. Acoustic recordings of deep scattering layers were maintained.

Meteorological observations were taken by the ship's officers/technicians at standard times. Meteorological soundings were taken twice daily by weather technicians from the U.S.-FGGE Project Office.

Neuston samples using a Manta net (.505 mm mesh) were taken at 12 stations beginning at 2000 hours from the *D. S. Jordan*. Squid specimens were preserved as were the marine insect *Halobates*, which are presently being examined by Lana Cheng of S.I.O. Squids were jigged at 13 stations. Specimens were measured and examined for maturity stage. The Cobb trawl (approximately 40 x 50 foot mouth area and 100 feet long with 3 mm mesh liner) was deployed from the *T. Cromwell* at three stations at 2000 hours. Squid specimens were saved. Five squid jigging stations were also conducted from this vessel.

RESULTS: Marine Mammals

The marine mammal survey may be divided into three parts or legs. Leg I was the first portion of the cruise track beginning at the home port and ending at Puntarenas, Costa Rica. Leg II was the second portion between Puntarenas and Manzanillo, Mexico. Leg III was the final portion from Manzanillo back to the home port. Marine mammal sightings along each of these legs are summarized in Tables 1 (*D. S. Jordan*) and 2 (*T. Cromwell*).

The main objective during Leg I was for the *D. S. Jordan* to survey the area outside the calibration area (Leg II) and also the area south of the Galapagos Islands. The objective for the *T. Cromwell* was to survey the extent of the equatorial dolphin distribution.

There were very few dolphin sightings in the tropical waters south of 20°N and west of the area later surveyed during Leg II, although whales were frequently seen south of 5°N. At the approach by *D. S. Jordan* to equatorial waters at 3°N and 103°W, northwest of the Galapagos Islands, spotted, whitebelly spinner, and striped dolphins (*Stenella attenuata, S. longirostris, S. coeruleoalba*) made their appearance. To the west unidentified dolphins were seen south of 5°N as the *T. Cromwell* approached the equator at 125°W. Along the equator itself, whose surface waters were unseasonably cool (<24.5 C), there were few dolphin sightings west of 102°W, except for a few unidentified species, pilot whales, and *Grampus*. However, whales were regularly encountered all along the equator. The main distribution of equatorial dolphins (spotted, spinner, striped, and common (*Delphinus delphis*) dolphins) was encountered only to the east of 102°W. South of the Galapagos Islands various whales, *Grampus*, pilot whales, common and striped dolphins were seen. The latter species was the most frequently sighted. This was also the case between the equator and Costa Rica along the *D. S. Jordan's* track into Puntarenas.

Leg II embodied the major objective of the 1979 survey. This was to accomplish an intercalibration of marine mammal density estimates, comparing between the two ships and that to be obtained from a PBY aircraft covering the same area. Both vessels began and ended the leg together, following zig-zag tracks that usually kept the ships within 200 miles of each other. There was a total of 501 sightings (449 separate records) of marine mammals involving at least 19 species (Tables 1, 2). Included are 82 sightings of spotted/ spinner dolphins, 27 striped dolphins, 16 common dolphins, and 99 whale sightings. Although the numbers of spotted and spinner dolphin schools sighted was the same for both ships (41), the species composition of all sightings was strikingly different. The *D. S. Jordan* logged 225 sightings of which 15% were spotted/spinner dolphins, and 28% were *Grampus*/pilot whales. In contrast the *T. Cromwell* logged 123 sightings of which 34% were spotted/spinner dolphins, and 9% were *Grampus*/ pilot whales. The difference was due mainly to the disproportionate numbers of *Grampus* schools seen from the *D. S. Jordan* (45 versus 7 from *T. Cromwell*) which appeared to be due to localized concentrations (Figure 4). The *D. S. Jordan* and *T. Cromwell* both searched approximately 100 miles each day and sighted an average of 12 and 7 dolphin schools per day respectively. Both vessels sighted an average of 2 spotted/spinner schools per day.

All of the track comprising Leg II lay in the warm tropical waters off Mexico and Central America. Yet distinct regimes of temperature and circulation were apparent, and there were corresponding differences in the distributions of some of the mammals.

Leg III was the return track for each vessel. Most sightings while still in the tropical waters were of whales or unidentified dolphins. Common dolphins were frequently seen north of the Revilla Gigedo Islands and off the Baja California coast. There were only 6 mammal sightings (from the *T. Cromwell*) in the subtropic waters west of 120°W. These were of whales, striped dolphins, pilot whales, and unidentified species.

A brief commentary on important species or species groupings follows:

Spotted/Spinner dolphin (*Stenella attenuata/S. longirostris*)

There were 106 sightings of spotted and/or spinner dolphins. The two species occurred together as mixed schools in 44 of these sightings. There were 53 pure schools of spotted dolphin, but only 9 pure schools of spinner dolphin (Tables 1 and 2).

44
9
53 spinner sighting

There were three main areas of distribution: (1) near the equator east of 103°W, (2) in Equatorial Counter Current waters between 3° and 10°N, and (3) in the warm (>27°C) anticyclonic flowing waters west of southern Mexico and north of 10°N (Figure 2). The equatorial sightings were in the transition zone between tropical and equatorial waters. Spinner dolphins seen there (7 sightings) belonged to the whitebelly (WB) race. Further west at 2°26'N, 129°41'W, a small school of southern WB spinners was identified. There were no other equatorial sightings of spotted/spinner dolphins west of 103°W, nor were there any seen south of 3°S. Spotted/spinner dolphins in the Counter Current waters appeared to be more abundant toward the periphery of the hydrographic regime dominated by the Costa Rica Dome (~9°N, 89°W). Both WB and eastern (E) spinner dolphins were seen between 3 and 10°N. The majority of spotted/spinner dolphin sightings occurred north of 10°N off southern Mexico. There were 42 sightings of E. spinners during Leg II (calibration area), and 40 of these occurred in those waters.

School size during Leg II ranged between 5 and 1075 animals among both pure and mixed schools. The mean size measured from the *D. S. Jordan* was 251 animals while it was 298 animals from the *T. Cromwell*. There were two modes to the size frequency of schools: one near the mean and the other at the <50 animals per school category.

Birds accompanied 74 of 82 schools of spotted/spinner dolphins seen during Leg II. Where a segregation of dolphins, birds, and fish was discernible, the birds appeared to be closely following the fish, and the dolphins were toward the rear of the feeding aggregation.

Fourteen schools, both pure and mixed, approached the ships and some animals rode the bow wave. These schools were generally encountered within 150 miles of land.

Spotted and spinner dolphins, especially the former, often disperse on approach of the ship, making them hard to follow. They are often seen "splash-leaping" at large distances, but once within about one mile of the ship, a more purposeful running, with little splashing, begins. When approached to within 1/4 mile, they usually break and run by leaping away across the surface with considerable splashing.

Within schools, subgroups of individuals were often seen exhibiting different behavior with respect to swimming speed, direction, and other responses to the ship. In mixed schools spotted and spinner dolphins appeared to be grouped separately.

Striped dolphin (*Stenella coeruleoalba*)

There were 72 sightings of this species (Tables 1 and 2) of which 60 were recorded by the *D. S. Jordan* and 12 by the *T. Cromwell*. The disparity was largely due to the former ship's different track which intersected the equator in three places east of 103°W, traversed the area south and northeast of the Galapagos Islands, and ventured into the area just north of the Costa Rica Dome.

Striped dolphin were sighted in cool, subtropic or transition waters northwest of the Revilla Gigedo Islands and close to the Mexican coast, in tropical waters of the Counter Current, in the vicinity of the Costa Rica Dome, and along and south of the equator (Figure 3). This species was particularly abundant close to the equator east of 103°W. However, unlike in other years, there were no equatorial sightings west of this longitude. There were likewise few (3) sightings in the warm (>27°C) waters off southern Mexico.

The largest school was estimated at 225 individuals. However, the average school size was only 50. This species is often initially seen leaping and splashing and is noted for its aerial displays. This "splash leaping" often continues throughout all distances of the ship's approach.

Striped dolphin are seldom seen with birds or with other dolphins. There were only 8 mixed schools, involving spinner, *Grampus*, common, or unidentified dolphins.

Common dolphin (*Delphinus delphis*)

Common dolphins were sighted 36 times by the two ships. They occurred mainly (1) near the equator at ~96°W and around the Galapagos Islands, (2) around the periphery and to the southwest of the Costa Rica Dome, and (3) in the cool waters off the Revilla Gigedo Islands and Baja California. The average school size was 117 animals. The largest school was estimated at 500 individuals. This dolphin is not usually in association with other species. Three schools were seen mixed with striped dolphins and two with other unidentified dolphins. There were 10 schools associated with birds.

The common dolphin is also notable for its aerial displays. Most "splash-leaping" was seen when the schools were still several miles away. Inside of one mile a more purposeful running mode often occurred.

Pilot whale (*Globicephala macrorhynchus*)

There were 50 pilot whale sightings. They occurred mostly along the equator east of 106°W and in the Counter Current between 5° and 9°N, over 350 miles from the coast. In the latter area, the sightings appeared to be arrayed or the southern, warm edge of the shallow thermocline, relatively cool waters emanating from the Costa Rica Dome (Figure 4). There was only one sighting in the warm waters off southern Mexico.

Pilot whales usually seem headed along a predetermined course, moving slowly, often in a file or line. They not infrequently sound for two to three minutes. One school appeared to momentarily "charge" one of the ships. School size was small, the mean being 32 individuals. When in association with other dolphins, it is usually with *Tursiops*. One school appeared to be feeding as there was much diving, and several birds were about the school.

Risso's dolphin (*Grampus griseus*)

Grampus were seen 65 times during this survey. The sightings occurred throughout the tropical waters and also south of the Galapagos Islands (Figure 4). The highest concentration was along the approaches to Costa Rica, an area of infrequent pilot whale sightings. *Grampus* were frequent in the warm, anticyclonic flow off southern Mexico, unlike the case for pilot whales. *Grampus* may have very localized and aggregated distributions, considering that *D. S. Jordan* logged 45 sightings to *T. Cromwell's* 7 over similar areas of Leg II.

This species travels in small schools that averaged only 20 individuals. They are frequently seen moving slowly, rafting, or rolling. The many small schools seen in localized areas may have been in social contact. Their response to a ship is variable. Some individuals approach, even "charge"; others avoid the ship or show a neutral response. Breeching and perhaps feeding behaviors were seen.

Grampus were seen with other species 15 times, most frequently with *Tursiops*. In one school, *Grampus, Steno,* and birds were together.

Bottlenose dolphin (*Tursiops truncatus*)

The 73 sightings of *Tursiops* were widely distributed throughout most areas surveyed (Figure 5). However, none was seen off Baja California or along the equator west of 96°W. Off southern Mexico, most sightings were within 300 miles of the coast.

The mean school size was 78, but this is biased upwards by mixed schools in which *Tursiops* were a minority component. Eighty-one percent of all schools seen contained less than 50 animals. *Tursiops* frequently associate with other species. They were seen with *Grampus,* pilot whales, spotted/spinner dolphins, Fraser's dolphin, *Pseudorca,* or *Steno* in 34 sightings. Forty-four percent of these mixed schools involved *Globicephala*. Only seven schools were associated with birds, four occurring in company with spotted/spinner dolphins.

This species shows little fear of the ship. They frequently approach the ship to leap alongside or ride the bow wave. Definite approaches were seen in 41 schools.

Rough-toothed dolphin (*Steno bredanensis*)

The 33 sightings of *Steno* (Figure 5) occurred on the equator (at 0°02'N, 120°45'W), in the Counter Current between 4° and 6°N, and off southern Mexico, where most sightings occurred with a distribution similar to that of *Tursiops*. The mean school size was 15.

There were eight mixed schools, involving *Grampus*, *Globicephala*, or *Tursiops*; six were with the latter. Thirteen schools were accompanied by birds.

This species, with its characteristic small school size and quiet behavior, has often been seen moving slowly in ranks, avoiding the ship by dodging rather than running. During this survey, it was surprising to see 16 schools actively approach the ship to circle, "splash jump", or ride the bow.

Killer whale (*Orsinus orca*)

There were only two sightings of this species in the tropical waters about 240 miles west of Cocos Island. School sizes were eight and nine animals. One school appeared to be attacking another school of small, black dolphins, and some body fragments were seen in the water.

Fraser's dolphin (*Lagenodelphis hosei*)

This species was seen on the equator at about 96°W. The school size was 200. There were *Tursiops*, pilot whales, and 300 storm petrels with this school. The Fraser's and bottlenose dolphins moved together in a characteristic, tight school.

False killer whale (*Pseudorca crassidens*)

There were three sightings of this species near the Galapagos Islands and off southern Mexico. School size ranged from 2 to 200.

Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)

Four schools were seen off Baja California, north of 27°N. Schools ranged from 1 to 40 individuals. One school was followed by about 125 Manx shearwaters.

Pygmy killer whale (*Feresa attenuata*)

The pygmy killer whale, considered a rare species, was sighted six times during this survey. One sighting was near the equator (2°32'S, 94°11'W), and the other five were in the tropical water southwest of Acapulco, Mexico (14°-16°N, 99-102°W). The latter sightings appeared to be from a localized concentration, since the species was sighted from both ships in that same area. The identification of *Feresa attenuata* was based upon behavior, external features, and photographs. The behavior of *Feresa* is distinctive, and it is interesting to compare it with that of *Peponocephala electra*, a species it very closely resembles in the field.

School sizes of *Feresa* were small, averaging 40 individuals per school and ranging from 21 to 70. In contrast *Peponocephala* schools usually number in the hundreds.

When *Feresa* were first encountered, the animals were seen rafting at the surface with little if any of the dorsal fin protruding. As the ship approached, the animals rose higher in the water until their dorsal fins fully emerged. The school would then be moving slowly away. Their escape response to the ship was similar to that of *Steno bredanensis*, except that *Feresa* always moved away from the ship. They formed small ranks and exhibited a general unhurried behavior. Some low "splash jumps" were seen, often followed by swimming several lengths under water. There were frequent changes of direction under water, and it appeared that they could travel over 100 meters submerged.

When followed closely, the animals changed direction frequently to evade the ship. When swimming fast under these circumstances, they often shot up a "rooster tail" of spray. This fast swimming was rather quickly replaced by slower swimming with the animals low in the water. They sometimes appeared to wait for other small groups to join up. Unlike *Peponocephala*, which runs in a single, tightly packed group, *Feresa* schools frequently split up into small groups going in different directions but reorganizing moments later.

"Spy hopping" and "tail slapping" behavior was seen. Individuals from two schools approached the ships closely, and one group rode the bow of the *D. S. Jordan*, providing the opportunity for identifying photographs.

Sperm whale (*Physeter catodon*)

Sperm whales were sighted 20 times (Figure 6). They were widely scattered about the equator and in the offshore waters off Central America. School size ranged from 1 to 31. In several of the larger schools, "lobtailling", "spy hopping", and "breeching" were observed. Photographs show that the breeching animals usually had a distinct and protruding "gular pouch."

Baleen Whales

There were 63 widely distributed sightings of baleen whales, most of which could not be identified to species (Figure 6). Sightings of blue whales (*Balaenoptera musculus*) were clumped between 8°-10°N, 92°-97°W to the southwest of the Costa Rica Dome and also off southern Baja California. Grey whales (*Eschrichtius robustus*) were sighted just south of San Diego, and humpback whales (*Megaptera novaeangliae*) were seen near the Revilla Gigedo Islands. Other identified species included the sei whale (*Balaenoptera borealis*), Bryde's whale (*B. edeni*), and the Minke whale (*B. acutorostrata*). There were four sightings, two of which were of sei whales, that were associated with birds and/or fish. One sei whale appeared to be feeding near a concentration of birds and skipjack tuna.

Other Whales

Beaked whales were widely distributed and frequently seen (Figure 6). There were 13 recordings of *Ziphius cavirostris* and 25 others, some very likely species of *Mesoplodon*. Five of the latter sightings occurred in equatorial waters, and most of the remainder were in the coastal or offshore waters off Central America and southern Mexico. These animals were brownish, less than 20 feet long, and the distinct beak was seen on several occasions. Their dorsal foreparts were often whiteish, sometimes in the form of a "blaze", and their dorsal fins were small, triangular, and situated on the rear third of the body. These animals usually sounded quietly as the vessel approached.

Another cetacean of interest, seen possibly eight times during this survey, may have been a species of *Kogia*, based upon field observations and photographs. These animals were seen within 150 miles of the coast off Central America and southern Mexico. The animals were less than 10 feet long, with triangular to slightly falcate dorsal fins. They were grey-brown in color and whiteish underparts were noted on some individuals. When first seen, they would be rafting at the surface, showing the dorsal surface from the blowhole area to the rear of the dorsal fin only. They made shallow dives to avoid the ship, or sounded with a sinking, rolling motion. No blows were seen. One group of four contained a calf.

Sea birds

The notable feature of the bird distribution of this year's survey was the low density of flocking birds along the equator and south of the Galapagos Islands. The sighting rate for sooty terns (*Sterna fuscata*) from the *T. Cromwell* averaged only 6 individuals per day on the equator between 122°W and 100°W, whereas it had been 363 per day during the three days of approach to, and the first day at the equator at 123°-125°W. The *D. S. Jordan* also reported few sooty terns. Less than 20 per day were seen as that ship crossed the tropical waters enroute to the equator, and none were seen on the track south of the Galapagos Islands. A similar situation held for wedge-tailed shearwaters (*Puffinus pacificus*), although that species is normally not abundant along the equator, as sooty terns sometimes are. Both sooty terns and wedge-tailed shearwaters were relatively abundant along the Leg II traverses off Central America and southern Mexico, there being several days when more than 100 of each species were counted per day. The main bird species in those waters, however, was the red-footed booby (*Sula sula*), which, with the above two species, often accompanied dolphin + fish associations. No red-footed boobies were reported from south of the equator although a large number of masked boobies (*Sula dactylatra*) were seen southeast of the Galapagos Islands.

Other important sea birds seen include the white-necked petrel (*Pterodroma externa*), north of the equator and relatively abundant in the central Pacific, and the dark-rumped petrel (*Pterodroma phaeopygia*) near the Galapagos Islands. The latter species was abundant at the southern limit of *D. S. Jordan's* southern track where a high of 67 per day was recorded. Galapagos storm petrels (*Oceanodroma tethys*) were seen on the equator 780 miles west of the Galapagos Islands and Markham's storm petrel (*O. markhami*) to the south, southeast, and northeast of those islands. Large numbers of pomerine jaegers (*Stercorarius pomarinus*) were seen (as much as 879 per day) with dolphin + fish schools in areas close to the coast.

Oceanography

Equatorial waters were between 23.5°-24°C, cool relative to surface temperatures this season in previous years. There were few sightings of dolphins or flocking birds, except east of 102°W, where many striped and common dolphins were seen. Whales, however, were frequently seen along the equator.

South of the Galapagos Islands, the summer thermocline was not so strongly developed as seen in previous years, and surface temperatures were a relatively cool 25°-26°C. Striped and common dolphins, *Grampus*, and pilot whales were seen there, but there was only one sighting each of spotted and whitebelly spinner dolphins. Both those sightings were within 200 miles of the islands. Flocking birds were noticeably absent from those southern waters.

There were two distinct regimes to the oceanography of the tropical waters off Central America and southern Mexico. The first was characterized by a broad ridge of shallow mixed layer depths (20-40 m) and strong thermocline gradient, extending southwestward from the coast between Costa Rica and the Gulf of Tehuauntepec, but emanating primarily from the Costa Rica Dome. Surface temperatures over the ridge were largely between 26° and 27°C. These waters appear to be a major habitat of striped and common dolphins, especially near the Costa Rica Dome. Other characteristic species are, *Grampus*, pilot whales, blue whales, *Tursiops*, and spotted dolphins in waters of 27°C or more.

North of the ridge and off the southern Mexican coast was a second regime. There, the surface temperatures were between 27° and 29°C, and mixed layer depths decreased to 10 m. The thermocline gradient, however, was relatively weak and deeper than found to the south. The resulting trough in the areal distribution of subsurface temperatures is consistent with the picture of an anticyclonic flow in that area. The most important species of these waters are the eastern spinner and spotted dolphins. *Grampus, Tursiops, and Steno* were also seen there. The eastern spinner, *Tursiops*, and *Steno* were more frequently seen in the southeasterly flowing, warm surface waters of 28°C or more.

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Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)

Date: July 27, 1979 Prepared by: David W. K. Au

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Scientist in Charge
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Date: July 27/79 Approved by: Izadore Barrett

Izadore Barrett
Center Director

Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)

Table 1. Summary of marine mammal schools sighted each day from *R/V David Starr Jordan* (January 3 - March 10, 1979)1/

	Noon position				DOLPHINS											WHALES			
Date	Lat.	Long.	Beaufort sea state	Miles searched	Spotted	Spotted and Spinner	Spinner	Striped	*Delphinus*	*Tursiops*	*Steno*	Pilot	*Grampus*	Other	UnID	Sperm	Baleen	Beaked	UnID
Leg I																			
Jan 3									1					*Lag. obl.*-2			1		
4	28°55'N	117°45'W	2-3	116					2			1			1	1			
5	24°38'N	117°44'W	2	116											1				1
6	20°23'N	117°36'W	2-4	123	1					1					1				
7	16°00'N	117°29'W	4	119				1		1							1		
8	12°39'N	117°21'W	4-5	118															
9	9°51'N	116°02'W	4-5	98															
10	9°17'N	112°18'W	4-5	105															
11	7°16'N	109°16'W	3-4	119															
12	5°01'N	106°04'W	2-4	117							1							1	1
13	2°58'N	103°17'W	2-3	112	1			2									1		
14	0°59'N	100°54'W	2-3	90	1		1*	2									1	1	3
15	0°30'N	98°00'W	0-1	97	1	1*	1	7				2			3			3	1
16	0°08'N	95°40'W	1-2	60	2	1*		10	4	3		4		Fraser's-1	3				1
17	2°18'S	94°16'W	3-4	88				1				1	1	Fraser's-1	2	1	2		3
18	5°03'S	92°34'W	3-4	88									1						
19	7°56'S	90°24'W	2-3	116				3							1				1
20	4°15'S	89°30'W	2-3	123				2				1			2	1			
21	1°27'S	88°39'W	1-2	90	1		1*	3	3	1				*Pseudorca*-1	3				1
22	1°37'N	88°05'W	3-4	122				3				1				3			
23	5°12'N	87°02'W	2-3	81	1			1		1					2			1	1
24	Cocos Is.		-	-															
25	7°23'N	86°07'W	1-3	87				3					1		4			1	
Leg II																			
30	8°28'N	86°19'W	1-2	80				2		3		2	16		3		1	1	6
31	6°05'N	89°15'W	2-3	117				2							1	1			
Feb 1	4°04'N	91°55'W	1-2	105	2			1		1	2	2	1	*Orcinus*-1	3				1
2	7°24'N	90°29'W	2-4	110				2		1		1	1		3				
3	8°55'N	90°23'W	5-6	112					2						1				
4	7°01'N	92°45'W	2-3	93						4		10	2		1		1		1
5	5°41'N	94°56'W	1-3	98	3			1		3	1	6			4		1		
6	8°42'N	93°09'W	2-3	90					3	2		3				1	3		1
7	10°57'N	91°25'W	3-4	99				3	3	1		2	1		4			1	
8	12°21'N	89°33'W	2-3	123	1			2	1	4								1	
9	11°54'N	92°13'W	2	85	2	1		5		1					2		2		1

*Whitebelly spinner

1/ Species in mixed schools are listed separately under the component species, except for mixed spotted and spinner dolphin schools.

Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)

Table 1. -Continued

Date	Noon position Lat.	Noon position Long.	Beaufort sea state	Miles searched	DOLPHINS Spotted	Spotted and Spinner	Spinner	Striped	*Delphinus*	*Tursiops*	*Steno*	Pilot	*Grampus*	Other	UnID.	WHALES Sperm	Baleen	Beaked	UnID
Leg II-Cont'd																			
Feb 10	9°25'N	95°07'W	3-4	121	1										1		2		3
11	8°45'N	96°37'W	3-4	95		1											1		
12	11°48'N	95°14'W	4-5	84						1			1		1		2	2	
13	13°27'N	94°44'W	5-6	112	2			1							1			1	
14	10°41'N	97°42'W	2-3	123											1				
15	8°49'N	99°49'W	3-4	108									1		2			1	
16	12°29'N	99°45'W	1-2	116	1		1			2			7		15		2	4	2
17	16°09'N	99°51'W	0-1	90	2.		1			3	4		1		4			2	1
18	14°45'N	97°43'W	2-3	82	1	4				2	2				1		2	1	2
19	12°26'N	99°58'W	5-6	128	1					2			1		3	1			
20	10°14'N	102°41'W	3-4	105				1				1			1			2	1
21	12°57'N	101°26'W	3-4	99						1	1		2		1		1	1	1
22	15°44'N	100°35'W	0-1	96	1				1		3		1	*Feresa*-1	2			1	3
23	14°16'N	102°35'W	1-2	89		4				5	3		8	*Feresa*-1	1			2	2
24	12°01'N	105°18'W	2-3	109		2									2				1
25	14°17'N	104°32'W	2-3	100	2	1		1		3	2		2		2			1	1
26	17°03'N	102°32'W	1-3	103	2	4	1				3								2
27	Manzanillo		-	-											1				
Leg III																			
Mar 3	17°44'N	105°46'W	3-4	106				1	1						3			1	
4	15°23'N	103°54'W	3	107							1				1		1		
5	13°25'N	111°50'W	2-4	103		1							1						1
6	16°10'N	113°21'W	3-4	113											3		1		2
7	20°02'N	114°03'W	2-3	116						1					3				
8	23°59'N	114°57'W	1	121					3						5		3	2	
9	27°50'N	115°45'W	3	119					2					*Lag.obl.*-2					
10	San Diego		-	-					1								1		

Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)

Table 2. Summary of marine mammal schools sighted each day from *R/V Townsend Cromwell* (January 5 - March 15, 1979)1/

Date	Noon position Lat.	Noon position Long.	Beaufort sea state	Miles searched	DOLPHINS Spotted	Spotted and Spinner	Spinner	Striped	*Delphinus*	*Tursiops*	*Steno*	Pilot	*Grampus*	Other	UnID	WHALES Sperm	Baleen	Beaked	UnID
Leg I																			
Jan 5	15°40'N	151°53'W	4	85															
6	13°33'N	148°49'W	4-5	123															
7	11°15'N	145°40'W	4-5	106															
8	9°10'N	142°45'W	6	91															
9	7°17'N	139°39'W	6-7	106															
10	5°53'N	136°36'W	5-6	111															
11	4°09'N	133°20'W	3-4	108											1		1		1
12	2°40'N	130°14'W	3-4	80			1*								2				
13	1°06'N	127°03'W	3-4	110											1	1			1
14	0°01'N	124°09'W	4	114															1
15	0°00'N	120°41'W	4	112							1						1		1
16	0°04'N	117°01'W	4	123												1			1
17	0°04'S	113°09'W	3-4	117													1	2	
18	0°05'N	109°28'W	3	125											1		1		1
19	0°00'N	105°15'W	2-3	122								1							
20	0°01'N	101°24'W	2-3	101				1				1			1	1	1		1
21	1°33'N	98°13'W	2-3	107		2*		1							1		1		1
22	3°53'N	95°00'W	1-2	120	3	1		2					1		2				
23	5°50'N	91°20'W	1	119	1			1			1	3		*Orcinus*-1	6	2		3	1
24	7°54'N	87°49'W	2-3	113					1	1			8						
25	Puntarenas		4	-						1					1				
Leg II																			
30	8°51'N	86°49'W	2	88					1	3		3	3		2				
31	7°09'N	89°52'W	3-4	119		1*		1	1				1		2				
Feb 1	5°15'N	92°32'W	3	112	3							1							
2	4°33'N	93°35'W	3	95	2	1									1				
3	8°15'N	91°52'W	4-6	103					1						1				
4	9°06'N	92°24'W	4-5	104					2								4		
5	6°55'N	95°09'W	2-3	119	2			1	1		1	1							1
6	8°31'N	95°06'W	2-3	84	1												3		1
7	11°35'N	93°43'W	3	93		1		2		1		1	1		2	1	3		
8	13°33'N	92°59'W	2-4	108		1	1			6					2				
9	10°45'N	96°02'W	3-4	116				1		2						1			

*Whitebelly spinner

1/ Species in mixed schools are listed separately under the component species, except for mixed spotted and spinner dolphin schools.

Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)

Table 2. -Continued

		Noon position				DOLPHINS											WHALES			
Date		Lat.	Long.	Beaufort sea state	Miles searched	Spotted	Spotted and Spinner	Spinner	Striped	*Delphinus*	*Tursiops*	*Steno*	Pilot	*Grampus*	Dther	UnID	Sperm	Baleen	Beaked	UnI
Leg II-Cont'd																				
Feb	10	8°21'N	98°36'W	5-6	120															
	11	10°22'N	97°46'W	4-5	103															
	12	12°32'N	96°44'W	6-7	36						1			1						1
	13	13°13'N	96°49'W	6-7	109													1		
	14	10°46'N	99°49'W	3	111	1	1		1							1				
	15	8°22'N	102°18'W	4	109								1			1				
	16	10°40'N	101°00'W	3-4	103		1	1												1
	17	13°14'N	99°21'W	2-3	93	1	5				1					1		1		
	18	14°32'N	99°19'W	2	97		6				1					4	1			3
	19	12°35'N	102°06'W	4	102		1													1
	20	10°33'N	104°56'W	4	91											1				
	21	12°42'N	103°31'W	3	94	1					1	1				1			1	
	22	15°23'N	101°51'W	2	74		1				3		1	1	*Feresa*-3	1				1
	23	14°47'N	103°30'W	2-3	85	3					3	5				2				1
	24	13°02'N	106°17'W	3	98	1	2				1	1							1	
	25	13°42'N	106°44'W	3	95										*Pseudorca*-2	4				
	26	16°13'N	104°58'W	1	80	3					1	1				3				
	27	Manzanillo		3	28												1			
Leg III																				
Mar	3	18°59'N	106°26'W	4	102	1											1			1
	4	18°57'N	110°07'W	3	103											1		1		1
	5	19°27'N	114°02'W	3	100					2								2		
	6	19°56'N	117°38'W	3	113	1														
	7	20°39'N	121°49'W	3	115				1											
	8	21°00'N	125°45'W	2	118											2				
	9	21°22'N	130°05'W	1-2	118								1							1
	10	21°38'N	134°08'W	3-4	110															
	11	21°52'N	138°12'W	3-4	116															
	12	21°54'N	142°07'W	3	113															
	13	21°51'N	146°23'W	2	113											1				
	14	21°45'N	150°34'W	4	114															
	15	21°27'N	154°23'W	4-5	109															

Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)

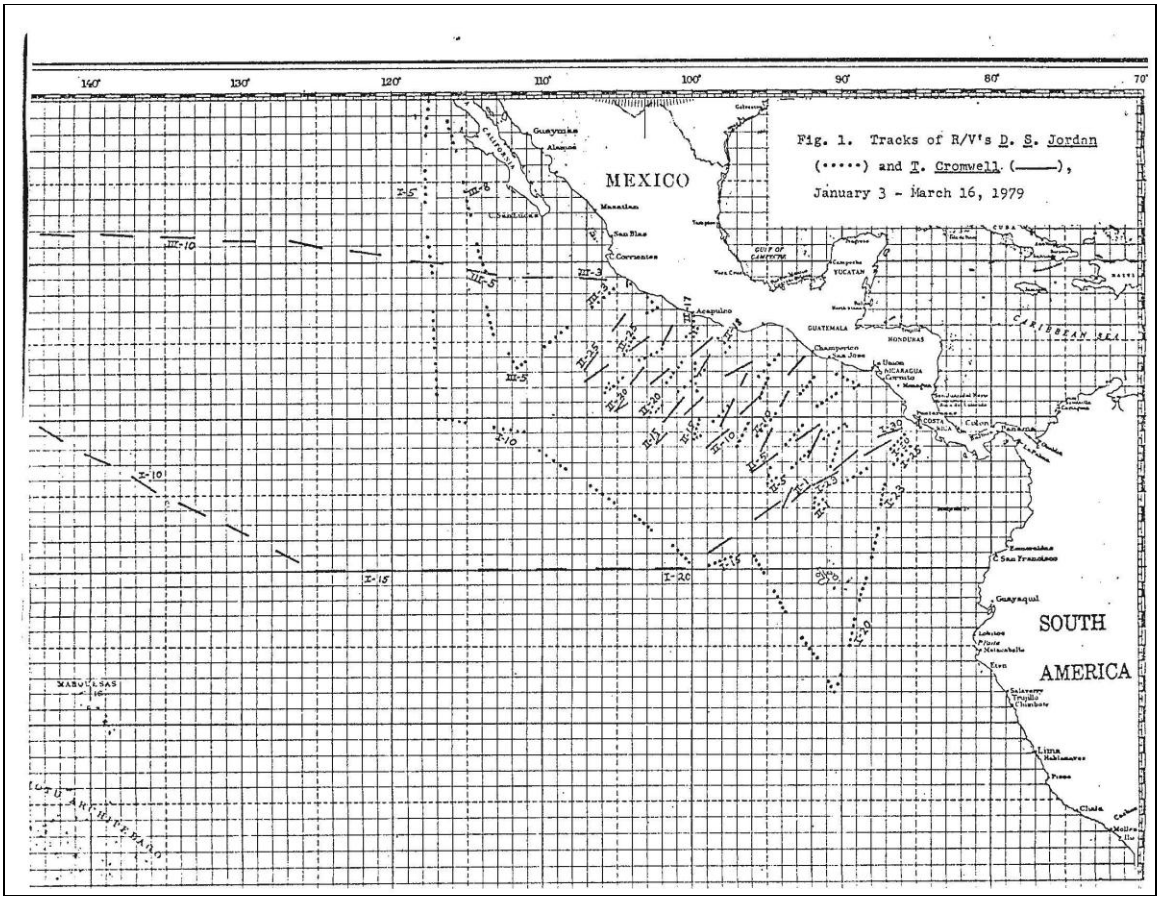
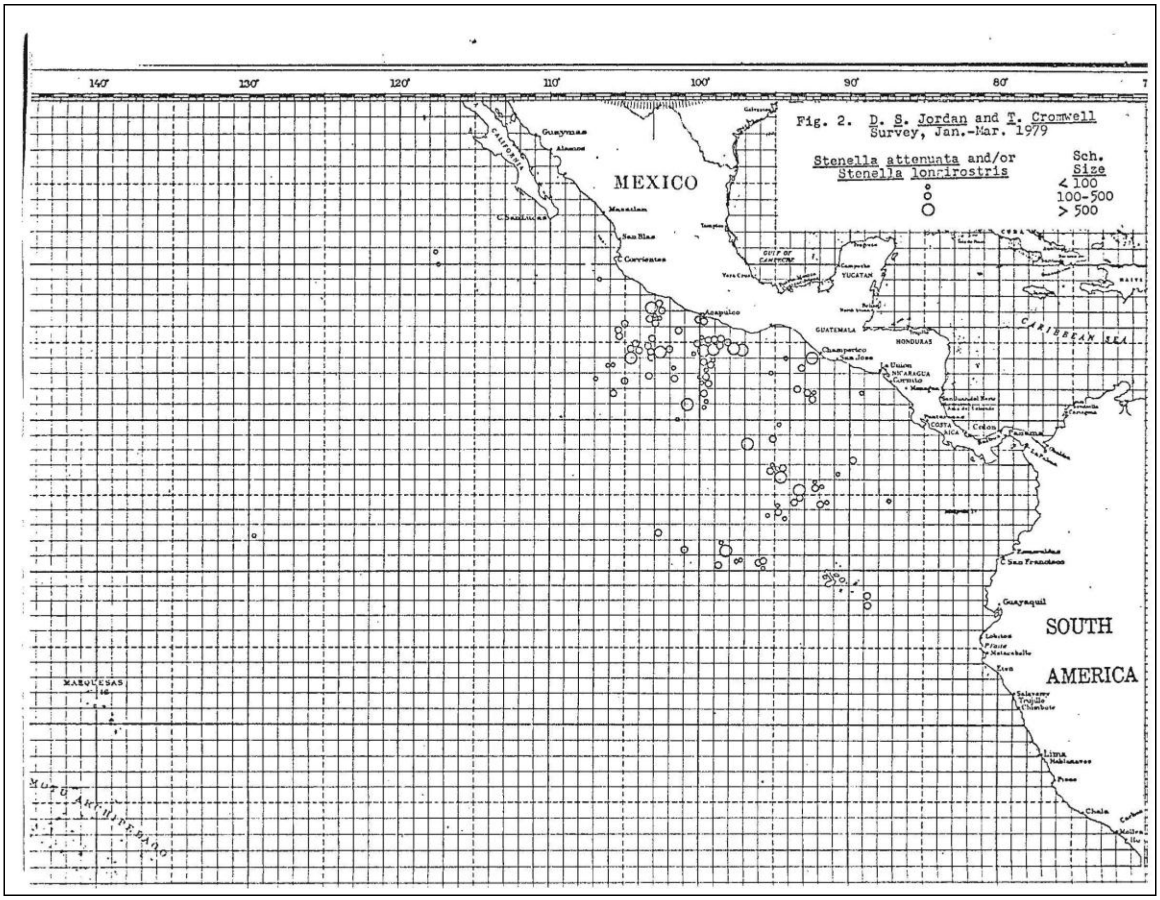
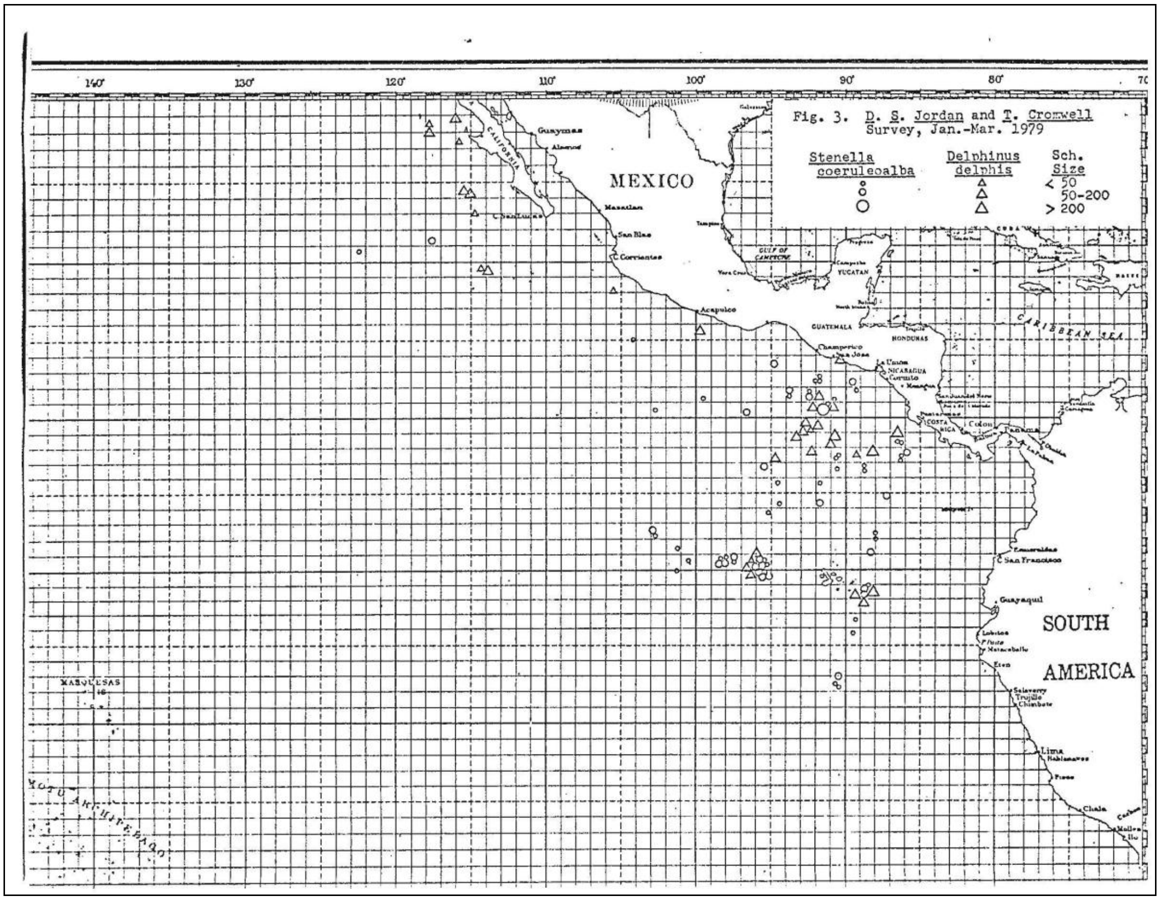


Fig. 1. Tracks of R/V's D. S. Jordan (•••••) and T. Cromwell (———), January 3 - March 16, 1979

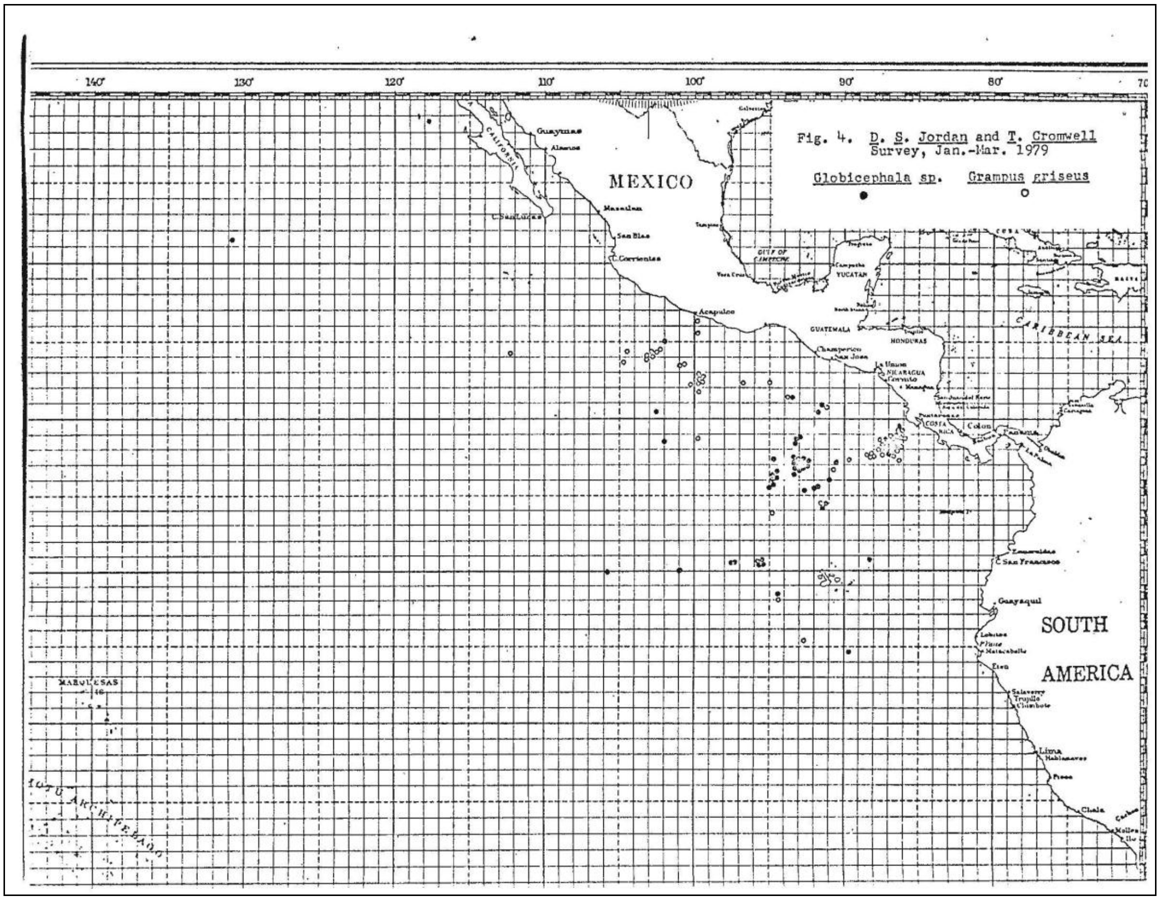
Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)



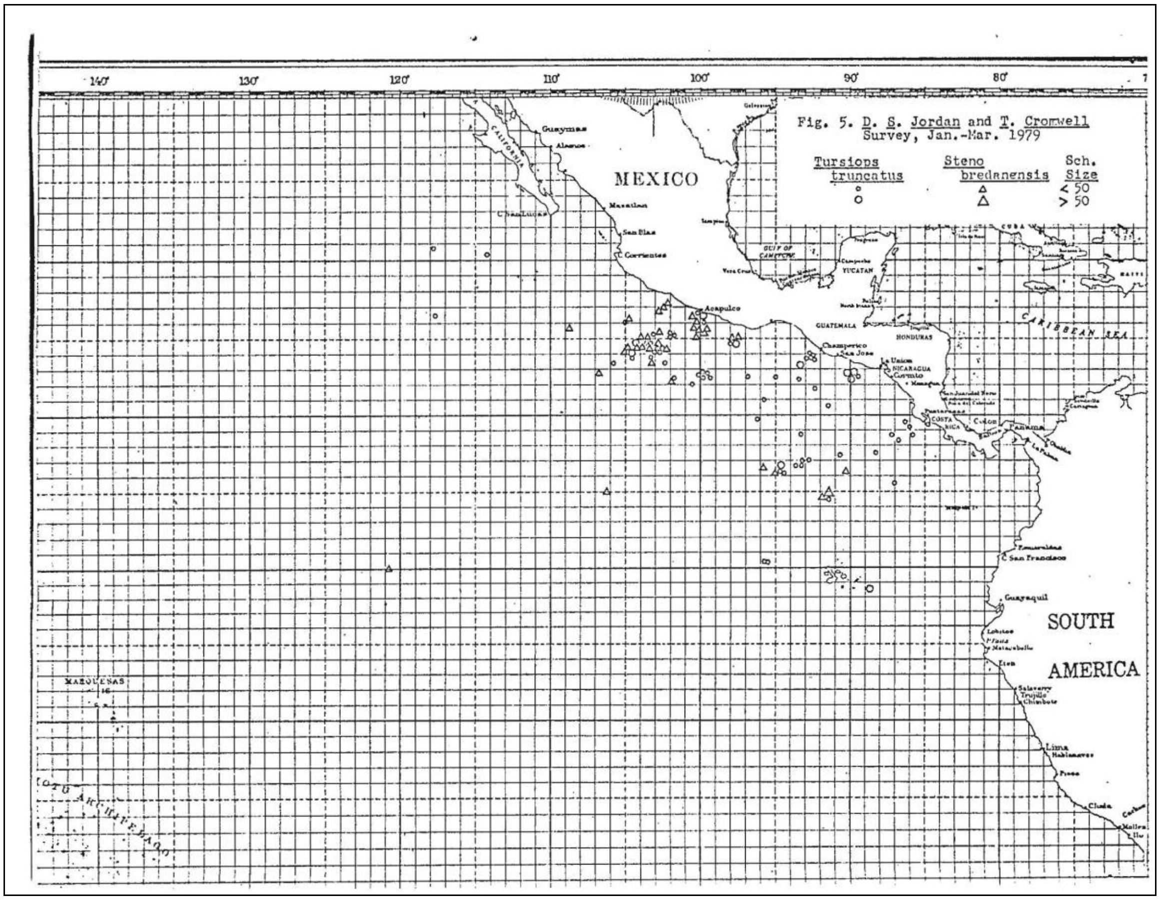
Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)



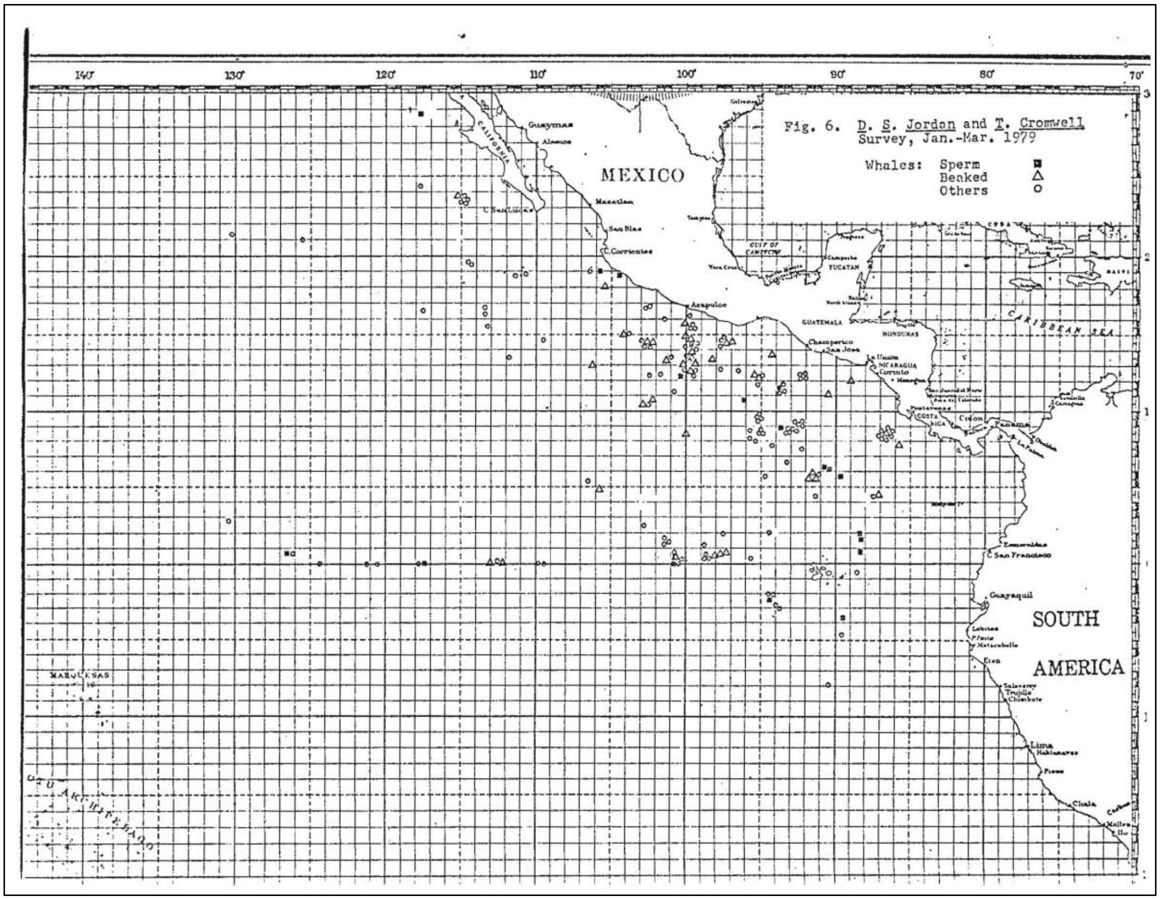
Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)



Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)



Appendix 2O. Cruise report for SWFSC Cruises 0463 and 0464. (Continued)



Appendix 2P. Cruise report for SWFSC Cruise 0564.

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

REPORT OF THE FIRST COASTAL MARINE MAMMAL SURVEY

R/V David Starr Jordan

PROJECT: Coastal Marine Mammals

VESSEL: R/V David Starr Jordan

CRUISE PERIOD: September 27 - October 24, 1979

ITINERARY:

September	27, 1979	Depart San Diego
October	20, 1979	Arrive San Diego
October	20, 1979	Depart San Diego
October	24, 1979	Arrive San Diego

OBJECTIVES:

1. To study movement and density patterns among marine mammals between inshore and offshore areas of the California Current.

2. To study the relationship of California Current populations to populations to the south that are involved in the tuna fishery.

3. To determine if there are times/areas deserving special consideration in assessments of population status.

4. To study time and area aspects of species interactions and behavior.

5. To study time and area aspects of school sizes.

6. To assess the importance of upwelling, convergences, shear zones, currents, and sea-floor topography to marine mammals in the California Current.

OPERATIONS:

The R/V D. S. Jordan searched for marine mammals along 27 legs in the California Current between Cape Mendocino, California and southern Baja California. Approximately 2,430 miles were searched. A 12-hour marine mammal watch was maintained daily, generally beginning at 0700 and ending at 1900 hours LMT. Vessel speed was between 9 and 10.5 knots.

The marine mammal search utilized 25 x 150mm Fuji binoculars. A pair was mounted port and starboard on the flying bridge. The distance to the horizon from that position was approximately 7 miles on a calm day. The observers stood 3-hour watches, interchanging positions (port and starboard) hourly. Upon sighting a marine mammal school, the ship was usually directed to approach it closely for identification, photography, school size estimations, and behavioral observations. At the conclusion of the observation, the ship would return to its predetermined course.

Hydrographic measurements consisted of expendable bathythermograph (XBT) drops and monitoring of the sea surface. XBTs were dropped each 6 hours daily (0600, 1200, 1800, and 2400 hours). Sea surface conditions were monitored by the ship's thermosalinometer; a surface salinity sample was taken daily.

Surface chlorophyll fluorescence was monitored continuously along the cruise track, along with atmospheric transmittance and path function at the spectral bands covered by the Coastal Zone Color Scanner (aboard the Nimbus-7 satellite). Additionally, periodic measurements were made of chlorophyll and phaeophytin concentration, downwelling and underwater spectral irradiance, secchi-disk depth, and Munsel ocean color. These measurements were obtained for comparison with biological distributions and with mesoscale features that are monitored by the Coastal Zone Scanner aboard the Nimbus-7 satellite.

A bird sighting log and an hourly watch log, recording sighting conditions, were maintained each day.

Meteorological observations were taken by the ship's officers at standard times.

The 24 major legs (transects) of the survey primarily traversed waters over the Continental Slope, off the Southern California Bight, and the Continental Borderlands.

RESULTS:

1. Marine Mammals. (Table 1)

There were 189 schools of 19 species of cetaceans, and 92 schools of 3 species of pinnipeds sighted during the cruise. Most sightings occurred in the waters off the Southern California Bight and between San Francisco and Cape Mendocino. Only 22 cetacean and 10 pinniped sightings occurred off Mexican shores. A brief commentary on the species seen follows:

Common Dolphin (Delphinus spp.) Figure 1.

This species was seen 48 times on 19 of the 27 legs. It occurred throughout the Southern California Bight; north of Cape Conception, it was primarily seen offshore in warmer, oceanic waters. Only 8 schools were seen off Mexican shores. School sizes ranged from 2 to 750 with a mean of 195. Seventeen schools were associated with birds or other species of marine mammals, most commonly the pinniped Zalophus californianus. Some of these mixed schools appeared to be feeding. All or parts of 21 schools approached the ship and frequently rode the bow wave. Calves were seen in 12 schools. There were many color pattern differences both between schools and between individuals within schools. Unlike most schools seen on the fishing grounds, only five schools had significant (>25) numbers of birds associated. Two of these schools were seen off Baja California.

Dall's Porpoise (Phocoenoides dalli). Figure 1.

There were 30 sightings on 7 legs of this species, which was often first seen rushing toward the ship. Most sightings were north of San Francisco in both nearshore and offshore waters. To the south, a few schools were seen along the shelf edge or upper slope, extending to the vicinity of the Channel Islands in the Southern California Bight. The average school size was 5 animals. None was clearly associated with birds or other mammals. Fifteen schools approached the ship, some to bow ride.

Risso's Dolphin (Grampus griseus). Figure 2.

This large species was seen 12 times on 7 legs, primarily in the Southern California Bight. Only one sighting (62 miles) was more than 50 miles from the coast. No sightings occurred in Mexican waters. School size ranged from 2 to 78 with a mean of 25. None was with sea birds, but 3 schools were associated with Tursiops or Zalophus. Most schools were moving slowly in small, scattered groups. Some schools avoided the ship. "Lobtailing" and "splash-jumping" behavior was seen.

Bottlenose Dolphin (Tursiops truncatus). Figure 2.

Seven of the 9 schools of this species sighted were mixed with other marine mammals. This species was encountered on 7 legs. One was with Zalophus, 2 were with Grampus, and the rest were with Globicephala, in one case, a Globicephala and Delphinus combination. Birds were present over 2 of these schools. The average size of these aggregations was 39. Seven schools approached the ship. Most of the Tursiops sightings occurred near the Channel Islands; two sightings were off Baja California.

Pilot Whale (Globicephala spp.). Figure 2.

This species was sighted 9 times on 6 legs primarily near the Channel Islands; two schools were seen off the Baja California coast. Two schools were with blue whales, and 5 were with Tursiops. One school consisted of an association of Globicephala, Tursiops, Zalophus, and a large number of birds. The average size of the schools was 26.

Pacific White-sided Dolphin (Lagenorhynchus obliquidens). Figure 1.

This species was seen 7 times on 4 legs between Southern California and Punta Eugenia, Mexico. It appears to be restricted to the near coastal waters. All schools were with birds, and all but 2 were also associated with other mammal species. Those included Zalophus, Delphinus, and humpback whales. Many schools appeared to be feeding. Three schools approached the ship. The school size of the aggregations ranged from 10 to 450 with a mean of 156.

Northern Right Whale Dolphin (Lissodelphis borealis). Figure 1.

Five schools were seen on 4 legs, all in Slope waters off Central California. Although these animals usually ran from the ship, several individuals of two schools approached the ship, some riding the bow for a long period of time. One was associated with birds. School size ranged from 71 to 319 with a mean of 165.

Striped Dolphin (Stenella coeruleoalba).

A small group of 5 animals was seen with a school of Delphinus in offshore waters southwest of Pt. Conception.

Baleen Whales. Figure 3.

The most frequent large whale seen was Balaenoptera musculus, the blue whale, which accounted for 21 of 37 sightings of baleen whales on 9 legs. School size ranged from 1 to 7. They were seen over the Continental Borderlands of the Southern California Bight and over the upper continental slope north of Pt. Conception, where several groups were seen adjacent to Pioneer Seamount. One blue whale was seen off Southern Baja California. Birds were associated with two sightings.

Humpback Whales (Megaptera novaeangliae) were seen 4 times on 3 legs between San Francisco and Punta Eugenia, Mexico, all within 50 miles of the coast. In one case, Lagenorhynchus, and in another, Zalophus, were "bow riding" the whales. Their behavioral repertoire included full breaching, half-breaching, spy hopping, tail slapping, and sticking their heads out of the water with mouths open.

Other baleen whales seen were 2 pairs of Bryde's whale (B. edeni), 2 Minke whales (B. acutorostrata), and 3 pairs of fin whales (B. physalus). Each Minke whale sighting was within a feeding aggregation of sharks, fish, and birds or of humpback whales, Zalophus, and birds. The fin whales and several other unidentified rorquals were in the Southern California Bight to the northwest of Tanner-Cortes Bank.

Toothed Whales other than Dolphins. Figure 4.

Three sperm whale (Physeter macrocephalus) schools were seen on 2 legs. One whale was seen near a blue whale in the Southern California Bight. Two other schools of size 12 and 13 were in blue oceanic waters off Central California. They occurred in spread out aggregations but with some individuals almost touching.

The rarely seen pygmy sperm whale (Kogia breviceps) was seen 4 times on Leg 15 (>160 miles offshore). Sighting conditions were very good on this leg, with winds of about 2 knots and a small swell. One sighting consisted of 4 animals, including an apparent mother-calf pair. Kogia were 12-15 feet long, brownish animals that rafted or rolled slowly at the surface. They appeared log-like and presented a characteristic profile with a sharp drop off at the rostrum and just behind the lobed dorsal fin located in the latter third of the back. Their blow was faint and to the left, and their heads were remarkably articulate. Several had low, long humps about midway between the head and dorsal fin.

Twenty ziphiid whales were seen. They were widely scattered over the areas surveyed. Two schools of 4 animals each were identified as Berardius bairdi. They were seen in the cooler waters north of San Francisco. They were characterized by their tight grouping, rapid blowing upon surfacing, and extensive scarring. On one occasion, full breaching and half-breaching were observed. Mesoplodon were identified 6 times on 2 legs. The scattered sightings (94-197 miles offshore) consisted of groups of 2 or 3 animals. At least 7 sightings were of Ziphuis cavirostris (23-117 miles offshore), a medium sized animal with whitish head parts. They were seen moving along slowly in groups of 1 to 5.

1. Pinnipeds

Three species, the California sea lion (Zalophus californianus), the northern fur seal (Callorhinus ursinus), and the northern elephant seal (Mirounga angustirostris) were seen. There was also one possible sighting of the Steller sea lion (Eumetopias jubatus). Zalophus was the most frequently seen pinniped, often occurring in mixed schools with cetaceans. Zalophus were encountered off Punta Eugenia, Mexico, but most were seen in the Southern California Bight. Callorhinus occurred mostly near Pt. Conception and to the north. The distribution of elephant seals, Mirounga, was notably different in that most sightings were far out over the continental slope, i.e. they tended to occur in oceanic waters traversed on the southern bound outer legs of the cruise.

2. Sea Birds.

Northern breeders that migrate to wintering areas to the south, i.e. jaegers, phalaropes, terns, and possibly leach's storm petrels, formed the bulk of the birds sighted. Northern breeders that winter off California, i.e. fulmars, kittiwakes, and several alcid species, were noticeably absent. Few shearwaters or other southern breeders were seen. Approximately 40 species of birds were sighted.

3. Environment

Some of the major features of the California Current System were revealed by surface water parameters: the colder (<18^{o}C), higher salinity (33.5ppt) nearshore waters mixing around Pt. Conception into the Southern California Bight; warmer, lower salinity waters offshore; the complex thermal features of the warmer Southern California Bight.

The distribution of mammal species appeared to be related to inshore (coastal) or offshore (oceanic) water masses. The movement and condition in each water mass could therefore differentially affect the mammal community, in terms of their biology, their abundance, and in terms of assessing the same.

Surface data collected, e.g. the chlorophyll measurements, suggest the frequent passage by the ship through areas of upwelling, watermass mixing, algal blooms, and convergences. An example, transect 4 (Figure 5), shows how mammal distributions might be affected by the environment. The ship evidently was passing through an area where coastal waters were mixing with oceanic waters and toward the western end of the transect a drift line, about which there were many seabirds, was encountered. Across the drift line, temperature rose, salinity and chlorophyll fluorescence dropped, and ocean color changed from green to blue. Grampus, Delphinus, Phocoenoides, and 3 pinniped species were sighted in the coastal water. Lissodelphis was seen in the mixing area, and a pod of 13 sperm whales was sighted in the blue oceanic water at the western end of the transect. Thus, these data, which will later be linked to satellite imagery from the Coastal Zone Color Scanner aboard Nimbus-7, suggest that the status of specific cetacean and pinniped species may be related to the extent and dynamics of coastal water masses, each with specific spectral signatures.

The effect of bottom topography on coastal marine mammals was not clearly seen, although escarpments and seamounts appeared important. The mammal sighting data will later be studied relative to circulation patterns induced by bottom topography and monitored by the Nimbus-7 satellite. The highest sighting rate occurred over the upper continental slope. However, the adjacent shelf waters were not comparably sampled.

SCIENTIFIC PERSONNEL:

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Approved by: John L. Carr for Izadore Barrett, Center Director 3/11/80 Date

Appendix 2P. Cruise report for SWFSC Cruise 0564. (Continued)

Table 1. Summary of cetacean schools sighted each day from R/V *David Starr Jordan*.

						DOLPHINS										WHALES				
Date	Leg	Noon Position Lat.N	Long.W	Beauf. sea state	Miles searched	*Delphinus*	*Phocoenoides*	*Grampus*	*Tursiops*	*Globicephala*	*Lagenorhynchus*	*Lissodelphis*	*Stenella coeruleoalba*	Other	UnID	Sperm	Baleen	Beaked	Other	UnID
9-27-79	1	32-05	118-27	3-4	101.8											1	3			
28	2	32-59	119-13	2-3	89.4	2			1		1						10			2
29	3	33-54	119-32	3-2	78.4	3		1	2	1							1			
30	4	34-13	121-41	1-4	98.5	1	1	4				1			1	1				
10- 1	5	35-43	121-52	2-3	97.1	1	1	1			1						3			1
2	6	37-20	123-18	2-3	71.2			1			1	2					5	1		
3	7	39-07	124-31	2-1	65.9	1	4					1								
4	8	40-28	125-39	2-3	95.3	1	9											1		
5	9	38-43	126-06	1-2	86.4	10	10								1	1				
6	10	37-48	125-08	2-1	97.1	2	4					1			2			3		2
7	11	36-18	123-59	2-4	94.6	3			1	1					1		1			1
8	12	34-23	123-05	3-4	109.5	1														
9	13	33-18	121-12	1-2	93.4	6		1					1		1		3	3		
10	15	31-19	120-07	1-2	84.7	3				1					2			5	*Kogia*-4	2
11	16	29-04	118-11	3-5	105.0				1									1		
12	18	26-27	116-40	4-5	109.3	1												1		
13	19	24-36	114-46	4	116.4															
14	21	22-29	112-47	4-5	115.2	1									1		1			
15	22	22-34	111-20	5-3	103.8	1				1							1	1		
16	23	25-10	113-40	5-6	104.9															
17	25	27-40	115-13	5-3	85.7	2					4				1		3			1
18	26	29-52	116-39	3-4	114.6				1									1		
19	27	31-53	117-56	3	74.4	4											1	1		
21	1a	33-45	119-19	4-2	57.3	2		1	1	1					1			1		
22	2a	33-38	119-41	2-3	38.1	3	1	4	1	4							3	1		
23	14	31-58	120-33	3-2	92.0									*Orcinus*-1			2			
24	3a	32-36	117-17	2-3	52.5															

8

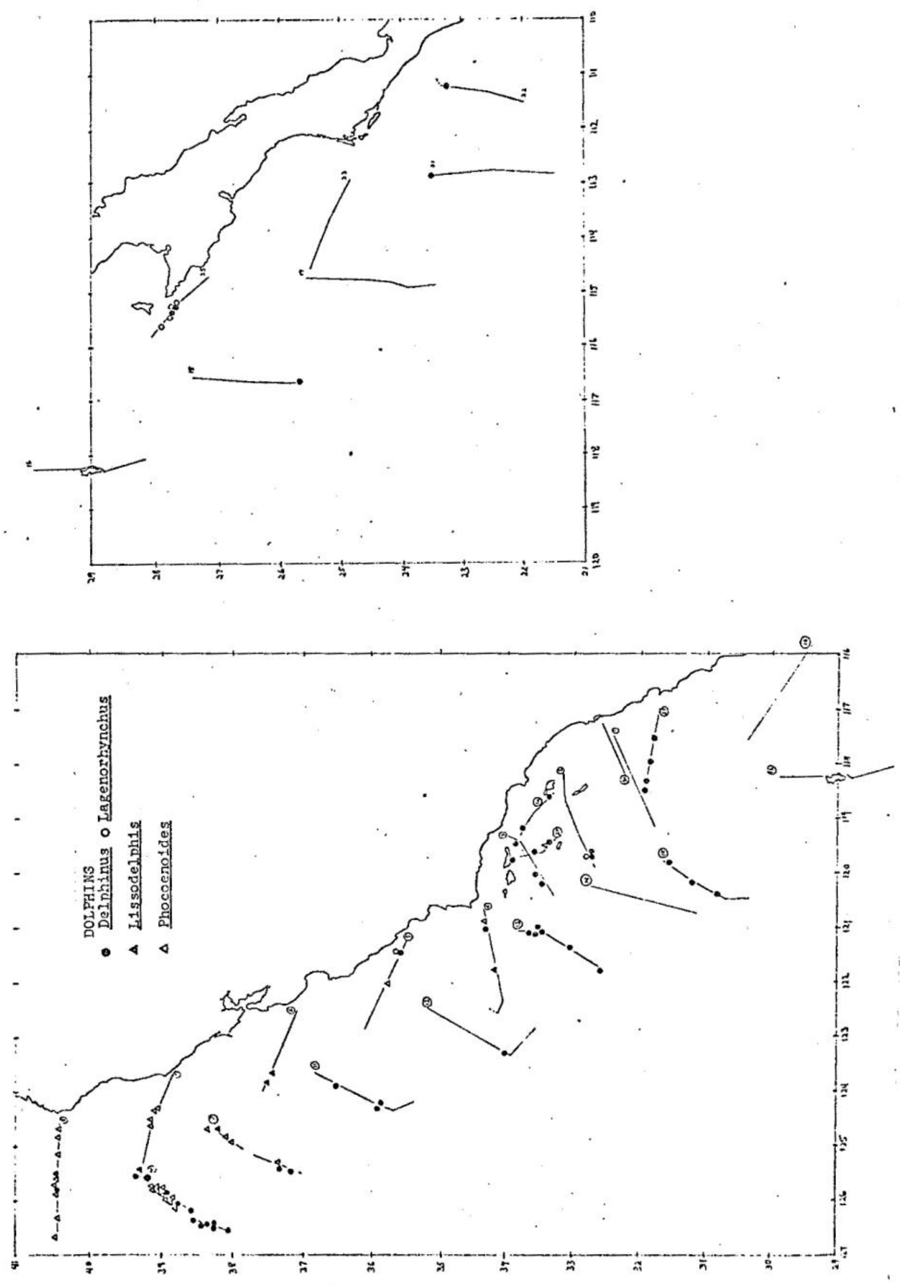

Figure 1. Sightings of Delphinus, Lagenorhynchus, Lissodelphis, and Phocoenoides

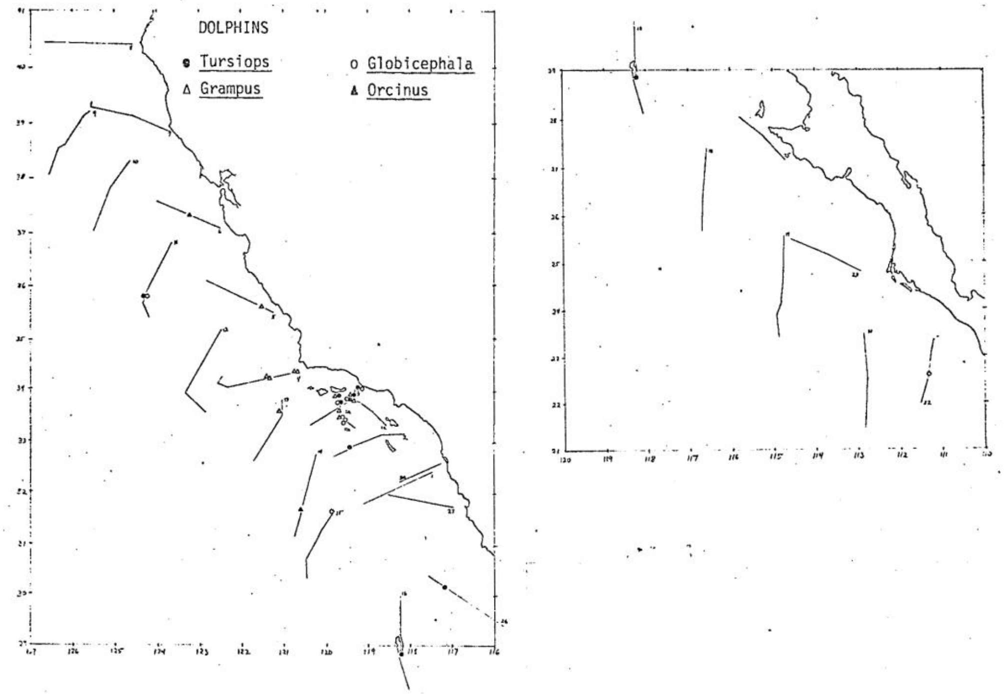

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Figure 2. Sightings of Tursiops, Grampus, Globicephala, and Orcinus

Appendix 2P. Cruise report for SWFSC Cruise 0564. (Continued)

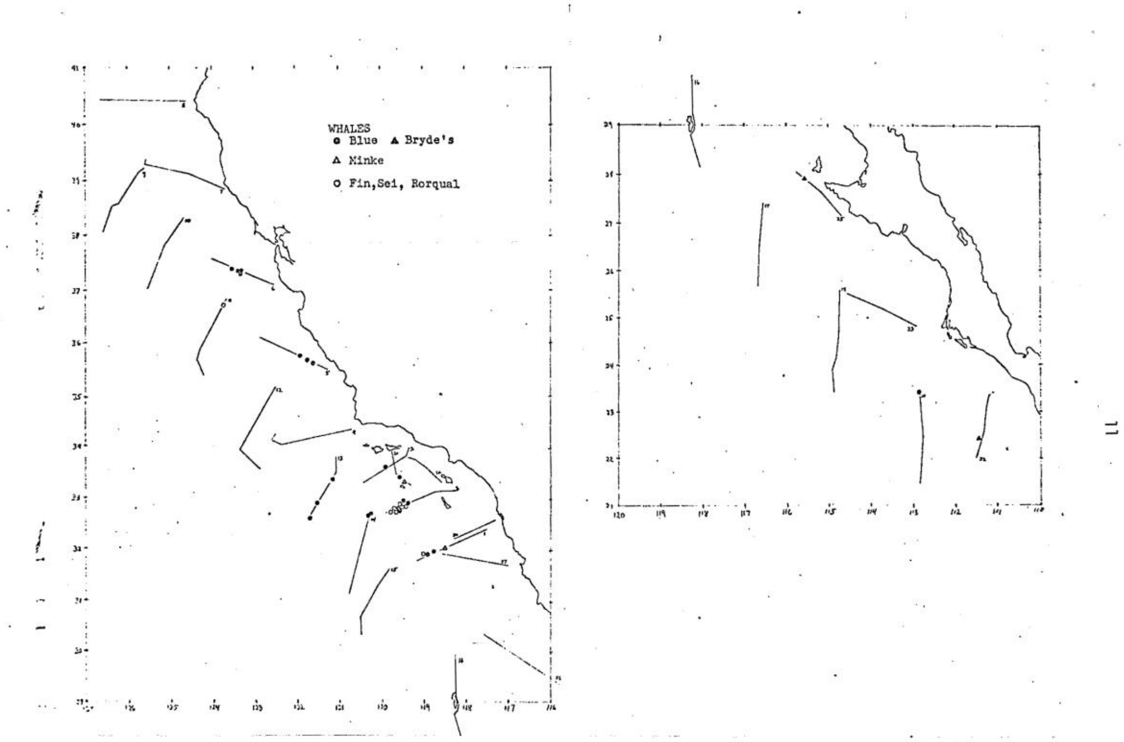

Figure 3. Sightings of Blue, Bryde's, Minke, and Fin, Sei, Rorqual Whales

Appendix 2P. Cruise report for SWFSC Cruise 0564. (Continued)

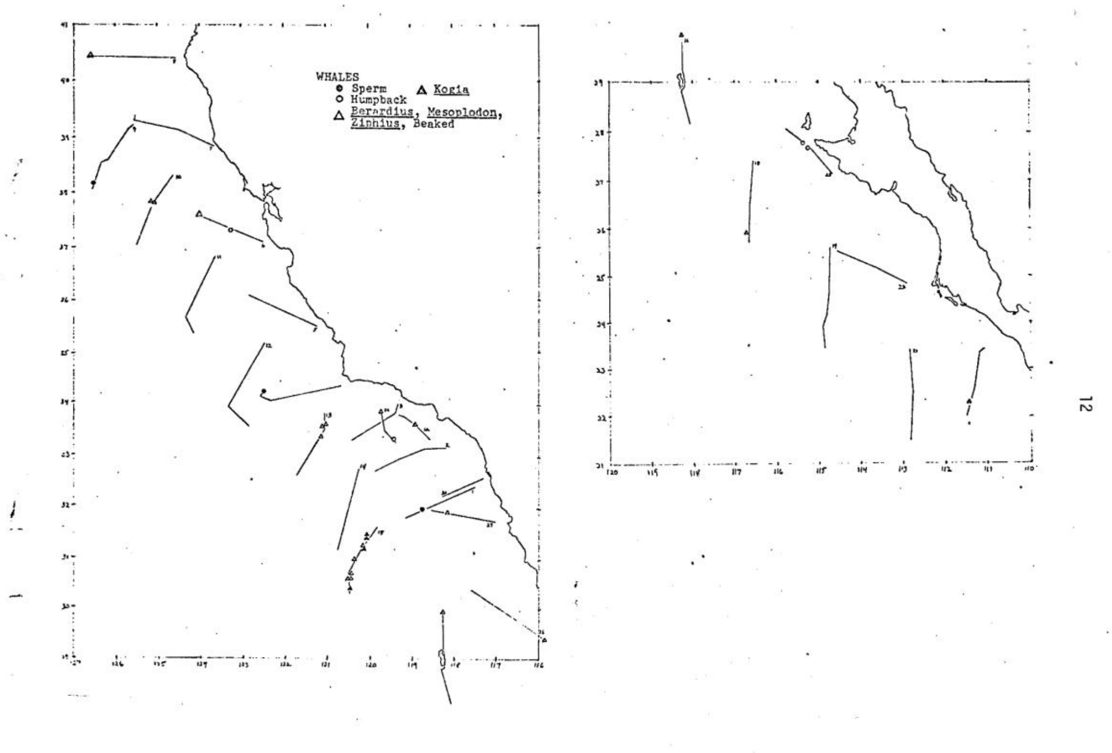

Figure 4. Sightings of Sperm, Kogia, Humpback, and Berardius, Mesoplodon, Ziphius Beaked Whales

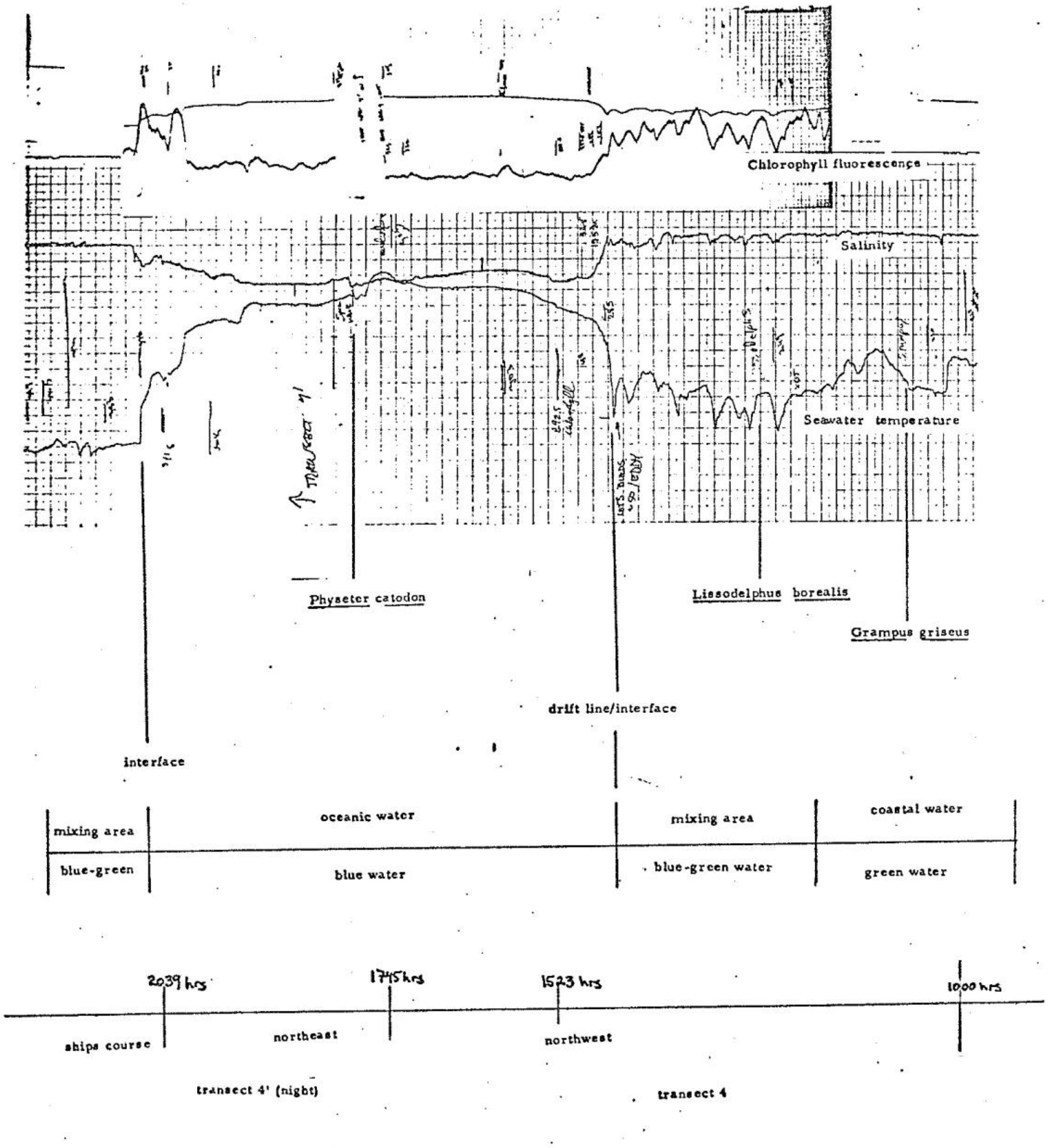

Fig. 5 Data from Transect 4, September 30, 1979

Table 1

Summary of cetacean schools sighted each day from R/V David Starr Jordan

						DOLPHINS										WHALES				
Date	Leg	Noon Posit. Lat. N	Noon Posit. Long. W	Beauf. Sea State	Miles Searched	Delphinus	Phocoenoides	Grampus	Tursiops	Globicephala	Lagenorhynchus	Lissodelphis	Stenella coeruleo.	Other	UnID	Sperm	Baleen	Beaked	Oth	UnID
9-27-79	1	32-06	118-27	3-4	101.8											1	3			
28	2	32-59	119-13	2-3	89.4	2			1		1						10			2
29	3	33-54	119-32	3-2	78.4	3		1	2	1							1			
30	4	34-13	121-41	1-4	98.5	1	1	4				1			1	1				
10-1	5	35-43	121-52	2-3	97.1	1	1	1			1						3			1
2	6	37-20	123-18	2-3	71.2			1			1	2					5	1		
3	7	39-07	124-31	2-1	65.9	1	4					1								
4	8	40-28	125-39	2-3	95.3	1	9											1		
5	9	38-43	126-06	1-2	86.4	10	10								1	1				
6	10	37-48	125-08	2-1	97.1	2	4					1			2			3		2
7	11	36-18	123-59	2-4	94.6	3			1	1					1		1			1
8	12	34-23	123-05	3-4	109.5	1														
9	13	33-18	121-12	1-2	93.4	6		1					1		1		3	3		
10	15	31-19	120-07	1-2	84.7	3				1					2			5	[illegible]-4	2
11	16	29-04	118-11	3-5	105.0				1									1		
12	[illegible]	26-27	116-40	4-5	109.3	1												1		
13	19	24-36	114-46	4	116.4															
14	21	22-29	112-47	4-5	115.2	1									1		1			
15	22	22-34	111-20	5-3	103.8	1				1							1	1		
16	23	25-10	113-40	5-6	104.9															
17	25	27-40	115-13	5-3	85.7	2					4				1		3			1
18	26	29-52	116-39	3-4	114.6				1									1		
19	27	31-53	117-56	3	74.4	4											1	1		
21	1a	33-45	119-19	4-2	57.3	2		1	1	1					1			1		
22	2a	33-38	119-41	2-3	38.1	3	1	4	1	4							3	1		
23	14	31-58	120-33	3-2	92.0									Orcinus-1			2			
24	3a	32-36	117-17	2-3	52.5															

Appendix 2Q. Cruise report for SWFSC Cruises 0598 and 0599.

Library

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National Marine Fisheries Service
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CRUISE REPORT

Report on the 1980 Porpoise Survey Cruises

R/V David Starr Jordan
R/V Townsend Cromwell

PROJECT: Porpoise Population Assessment

VESSELS: R/V David Starr Jordan, Cruise DS 80-1 (PC-598)
R/V Townsend Cromwell, Cruise TC 80-1 (PC-599)

CRUISE PERIOD: January 3 - March 5, 1980

ITINERARY:

1. David Starr Jordan

January 3, 1980	Depart San Diego
January 28, 1980	Arrive Rodman, Canal Zone, Panama
January 31, 1980	Depart Rodman
February 13, 1980	Arrive Manzanillo, Mexico
February 16, 1980	Depart Manzanillo
March 5, 1980	Arrive San Diego

2. Townsend Cromwell

January 3, 1980	Depart Honolulu
January 29, 1980	Arrive Rodman, Canal Zone, Panama
February 1, 1980	Depart Rodman
February 11, 1980	Arrive Acapulco, Mexico
February 14, 1980	Depart Acapulco
March 5, 1980	Arrive Honolulu

OBJECTIVES:

To investigate density gradients of porpoise populations in the eastern tropical Pacific.

To study school structure, behavior, species differences, trophic interactions, and effects of environment in different portions of the porpoise habitats.

OPERATIONS:

A 12-hour marine mammal watch was maintained each day, generally beginning at 0600 and ending at 1800 hours. The ships searched approximately 100 miles each day at speeds between 9 and 11 knots.

The marine mammal search utilized 25 x 150 mm Fuji binoculars aboard D. S. Jordan and 20 x 120 mm USN MK-3 binoculars aboard T. Cromwell. A pair of these binoculars was mounted port and starboard on the flying bridge aboard D. S. Jordan and on the bridge wings aboard T. Cromwell. The distance to the horizon from these positions was approximately 7 and 5.5 miles respectively from each ship. The observers stood 3-hour watches, interchanging positions port and starboard hourly, and rotating their time spent on the binoculars throughout the watch. The ship usually approached each school for identification, photography, school size estimation, and behavioral observations.

XBT's were dropped at 0600, 1200, 1800, and 0000 hours daily. The thermosalinograph recorders were run continuously, and a salinity sample was taken daily.

Bird, sighting conditions, and meteorological logs were kept. Surface chlorophyll was measured continuously aboard D. S. Jordan, along with light irradiance, ocean color, and Secchi Disk measurements.

RESULTS AND OBSERVATIONS:

Cetaceans (Tables 1 and 2, Figure 1)

There were 338 separate sightings of cetaceans from D. S. Jordan and 161 from T. Cromwell. Figure 1 is a plot of the sightings of *Stenella attenuata*, *S. longirostris*, *S. coeruleoalba* and *Delphinus delphis*. These species made up 32% of all the sightings.

Stenella attenuata and *S. longirostris* (spotted and spinner dolphins) were widespread in the tropical waters of the eastern Pacific. They were frequently encountered off southern Mexico and along the 10°N line in the Central American Bight. There they often occurred in large, mixed schools, in association with feeding tuna and birds. Individuals from many of the schools occurring near the coast approached the ships to bow ride. There was no evidence that extensive populations inhabited the equatorial waters.

Stenella coeruleoalba (striped dolphin) was also widespread but were most often seen in the oceanographically distinct southern half of the Central American Bight. *Delphinus delphis* (common dolphin) was more coastal in distribution. Most of the schools seen were near the Gulf of Panama and the environs of the Costa Rica Dome.

Other interesting species seen include both delphinids and whales. At least 1, possibly 4 schools, of *Feresa attenauta* (pygmy killer whale) were seen in widely scattered localities in the tropical waters. All schools displayed the classic behavior pattern of the species. A school of Lagenodelphis hosei (Fraser's dolphin) was seen near the equator, and it appeared to be associated with 17 sperm whales. There were 11, possibly 15, sightings of Kogia sp. (probably K. simus, the dwarf sperm whale). These little whales have a very characteristic appearance and behavior and differ from the Kogia sp. (probably K. breviceps) that had been seen off California on the coastal marine mammal cruise (DS 79-10). Kogia were seen throughout the Central American Bight in calm seas, often along slick lines. Mesoplodon sp. were seen 17 times. Six, possibly 9, of the pods contained at least one individual with a whitish, chevron shaped, blaze on the dorsal surface ahead of the dorsal fin. Mesoplodon sp. appear to be a relatively common small whale of the ETP, and the type with the chevron blaze is a very characteristic species. There were 4 sightings of Balaenoptera musculus (blue whale) seen west of the Costa Rica Dome. That area is now noted for its blue whale population.

A most interesting sighting was a pod of 3 medium sized whales, identified as Hyperoodon sp., seen at 4-38N, 98-05W. These large, up to 30 feet long animals, were whitish grey, and their bodies were very robust (whale like). They had tall dorsal fins (like that of Grampus), a stubby, Tursiops-like rostrum, and a very bulbous melon. They were initially associated with 10 Globicephala macrorhynchus (pilot whales). After several slow rolls and swimming just below the surface, they sank from view. A very similar sighting of undoubtedly the same species occurred during the 1977 porpoise cruise (DS 77-1). That sighting was of about 15 animals at 2-18N, 118-36W, described as up to 30 feet long (a 6-8 foot individual was also present); with bulbous or "football helmet" whitish melon; bottlenosed or Tursiops-like beak, about 6-12 inches long; and with high, falcate dorsal fin. These sightings are of great interest because the genus Hyperoodon is not yet known to occur with certainty in the north Pacific.

Both ships passed through the area of the Costa Rica Dome. Delphinus delphis, Stenella coeruleoalba, and Tursiops truncatus (bottlenose dolphin) were the most frequently seen species in that area where gale force winds were blowing. As D. S. Jordan appeared to pass across the northern edge of the "dome", bird abundance increased and 3 S. attenuata schools approached the ship.

The western extension of the "porpoise-tuna" fishing grounds was investigated by both ships after leaving Mexico. This is the area west of 110°W and centered approximately at latitude 10°N, an area not previously surveyed for porpoise densities. Beaufort 5-6 and Beaufort 3-4 wind conditions were typical along approximate latitudes 10°N and 5°N respectively for D. S. Jordan and T. Cromwell respectively. Because the ships were proceeding downswell and westward, these weather conditions were tolerable for effective searching. The results of this effort suggest that S. attenuata and S. longirostris (whitebelly race) are narrowly distributed about the 10°N divergence zone in small schools (size range 20-80) during this season. These schools, attended usually by Pterodroma petrels, were noticeably different from the large , (apparently) feeding schools in the eastern Pacific that are associated with tuna and swirling boobys, frigates, terns, and shearwaters.

RECOMMENDATIONS

Planning for this 1980 porpoise survey, like with other similar surveys,was a complicated exercise due to diverse requirements of porpoise assessments, and the large number of persons involved during planning and execution of the survey. As a result, input for planning from interested persons were not received on a timely basis and the ship tracks were not finalized until the sailing day. Furthermore, mid-track changes were required and communicated to the ships while at sea. A "final" cruise plan and track, dated January 28 reached the ships while in Panama. These delays in finalizing the cruise plan created difficulties for both the ship and scientific crews and should be avoided in the future.

SCIENTIFIC PERSONNEL:

1. R/V David Starr Jordan

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2. R/V Townsend Cromwell

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   Larry Hansen, Biological Technician, SWFC

Prepared By: David W. K. Au   9-15 80
David W.K. Au   Date
Chief Scientist

Approved by: Izadore Barrett   Sept. 15, 1980
Izadore Barrett   Date
Center Director

Appendix 2Q. Cruise report for SWFSC Cruises 0598 and 0599. (Continued)

-5-

Table 1. David Starr Jordan

Sightings per Day by Species

Date	Bft Sea State	Stenella attenu.	S. longi WB	S. longi E	S. longi UnID	Stenella coeruleo.	Delphinus	Grampus	Globiceph.	Tursiops	Steno	Other	UnID	Sei (S)	Brydes (B)	Other Rorqual	Mesoplod.	Other Ziphiid	Sperm	Other	UnID
		Delphinids												Whales							
1-4-80	4						4											1Z 2			
1-5	2-3					2							1								
1-6	2	1				1				1			1								
1-7	3-4																				
1-8	4												1								
1-9	5-4	1						1	1				1								
1-10	4-5	1		1									2								1
1-11	6												1								
1-12	6-5												1								
1-13	4-3																				
1-14	3-2-3	3	2							1											
1-15	2-3	1	1			1		1					3					1			
1-16	2-3-2	3	1								1	1-Ps	2								1
1-17	2-1	1	1			2					2	1-F?	1				1			2-K	
1-18	2-1-2	3							3	1	1		1				3			1-K	6
1-19	2-3	3	1					1	2				1							1-H?	
1-20	2-3					2		1				1-O	1				1				
1-21	2-3	1	1			4		3	1	1			1						2	1-K	
1-22	0-2	1				2				1	1		1				1		3	3-K	1
1-23	4-3-4					1							1						2		
1-24	3-4-3					2							2								1
1-25	2					2		2		1	1		2								2
1-26	2-3					2		3		1			1			1	2			1-K	1

Z = Ziphius F= Feresa H=Hyperoodon

Appendix 2Q. Cruise report for SWFSC Cruises 0598 and 0599. (Continued)

-6-

Table 1. David Starr Jordan (cont'd)

Sightings per Day by Species

		Delphinids												Whales							
Date	Bft Sea State	Stenella attenu.	S. longi WB	S. longi E	S. longi UnID	Stenella coeruleo.	Delphinus	Grampus	Globiceph.	Tursiops	Steno	Other	UnID	Sei (S)	Brydes (B)	Other Rorqual	Mesoplod.	Other Ziphiid	Sperm	Other	UnID
1-27-80	3-4-3					1	1										1			1-K	
1-28	4-2										1		1			1-S/B					
2-1-80	6-7-4	2					1									2					
2-2	2	2		1		4		1					3		1	1-S/B				2-K	
2-3	3-5																				
2-4	7-6-3	4				1		2	1	1			2								1
2-5	6					1	1			4		1-O	2								
2-6	6-5	3				2	3		1	3			2		2	2-S/B					
2-7	6					1	1	3		1			1			1-Bl		1			
2-8	3-4-3	1				3	1			1		1-O 1-F	1								
2-9	2-3-4	2						1					3				1			1-K	
2-10	3-4	5				1	2		1				1								1
2-11	3-4	4		2				2		1	1		1				1				
2-12	2	1				1		1				1-F	8		1	1-Mk	3				
2-13	3-2	3									1		4								
2-17	3-4-5	1		1						2			2						3		1
2-18	3-4	1				1															
2-19	3-4	2				1		1				1-Ps				1					
2-20	3-4					1															
2-21	5-6		2								1		2								2
2-22	6		1			2		1	1	1											1
2-23	5-6	1											1		1						1
2-24	6		1										2								

K = Kogia O = Orcinus Mk = Minke Bl = Blue

Table 1. David Starr Jordan (cont'd.)

Sighting per Day by Species

		Delphinids												Whales							
Date	Bft Sea State	Stenella attenu.	S. longi. WB	S. longi E	S. longi UnID	Stenella coeruleo.	Delphinus	Grampus	Globiceph.	Tursiops	Steno	Other	UnID	Sei (S)	Bryde's (B)	Other Rorqual	Mesoplod.	Other Ziphiid	Sperm	Other	UnID
2-25-80	5	2	2			1															
2-26	5-6											1-Ps	2								
2-27	5-4						1		1												
2-28	3-4-5											1-Ps	2						1		
2-29	5												2								
3-1	3								1				3								
3-2	2-3								1				3			1					1
3-3	3-4-3						1			1											
3-4	3-2						1	1					2								1
3-5	2						1	1				4-L								2-G	

Pc = Pseudorca G = Grey Whale

Appendix 2Q. Cruise report for SWFSC Cruises 0598 and 0599. (Continued)

Table 2. Townsend Cromwell

Sightings per Day by Species

		Delphinids												Whales							
Date	Bft Sea State	Stenella attenua.	S. longi. WB	S. longi E	S. longi UnID	Stenella coeruleo.	Delphinus	Grampus	Globiceph.	Tursiops	Steno	Other	UnID	Sei (S)	Bryde's (B)	Other Rorqual	Mesoplod.	Other Ziphiid	Sperm	Other	UnID
1-3-80	–																		1	1-HB	
1-4	3-2-5											1-Ps									
1-5	3-4																				
1-6	2-3							1					1								
1-7	3-4																				
1-8	4																				
1-9	4-5																				
1-10	5-6																				
1-11	6																				
1-12	7																				
1-13	6-5												1								
1-14	4-3																				
1-15	2-3	2											1						1		
1-16	3	1																			
1-17	3-4								1				2						1		
1-18	2-3											1-Lg	1						1		1
1-19	3-5												2			1	1				1
1-20	4	1							1				1			1					
1-21	3-4								2		1		5			1S/3					2
1-22	4-5												2								
1-23	4-5							1	2			1Ps	3								1
1-24	2-1-3	5	1	2									3						1		
1-25	2-1			1				1	1	1			2				1		1		

HB - Humpback   Lg - Lagenodelphis

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Table 2. Townsend Cromwell (cont'd)

Sightings per Day by Species

		Delphinids												Whales							
Date	Bft Sea State	Stenella attenu.	S. longi. WB	S. longi E	S. longi UnID	Stenella coeruleo.	Delphinus	Grampus	Globiceph.	Tursiops	Steno	Other	UnID	Sei (S)	Brydes (B)	Other Rorqual	Mesoplod.	Other Ziphiid	Sperm	Other	UnID
1-26-80	2-3-4									3									1		1
1-27	2-1	2			1	1				1								1			2
1-28	2-1-5						3						2								1
2-2-80	6-4-3						2						2								
2-3	3															1					
2-4	2-3-6																				
2-5	7-6-5						3														
2-6	3-5									4			4								
2-7	4-5					2							4			3-B1					1
2-8	4									1			3			2					1
2-9	3-2	4		4						2			1								1
2-10	1-2	4		1						1		1Ps									
2-14	–	1																			
2-15	2-3-4	2		1	1								1								
2-16	3-4	1		1																	
2-17	2-3	3																			
2-18	3-4	1		2						1		1-F/P									1
2-19	3-4												2								
2-20	4																				
2-21	4																	1			
2-22	3-4																1		1		

Appendix 2Q. Cruise report for SWFSC Cruises 0598 and 0599. (Continued)

-10-

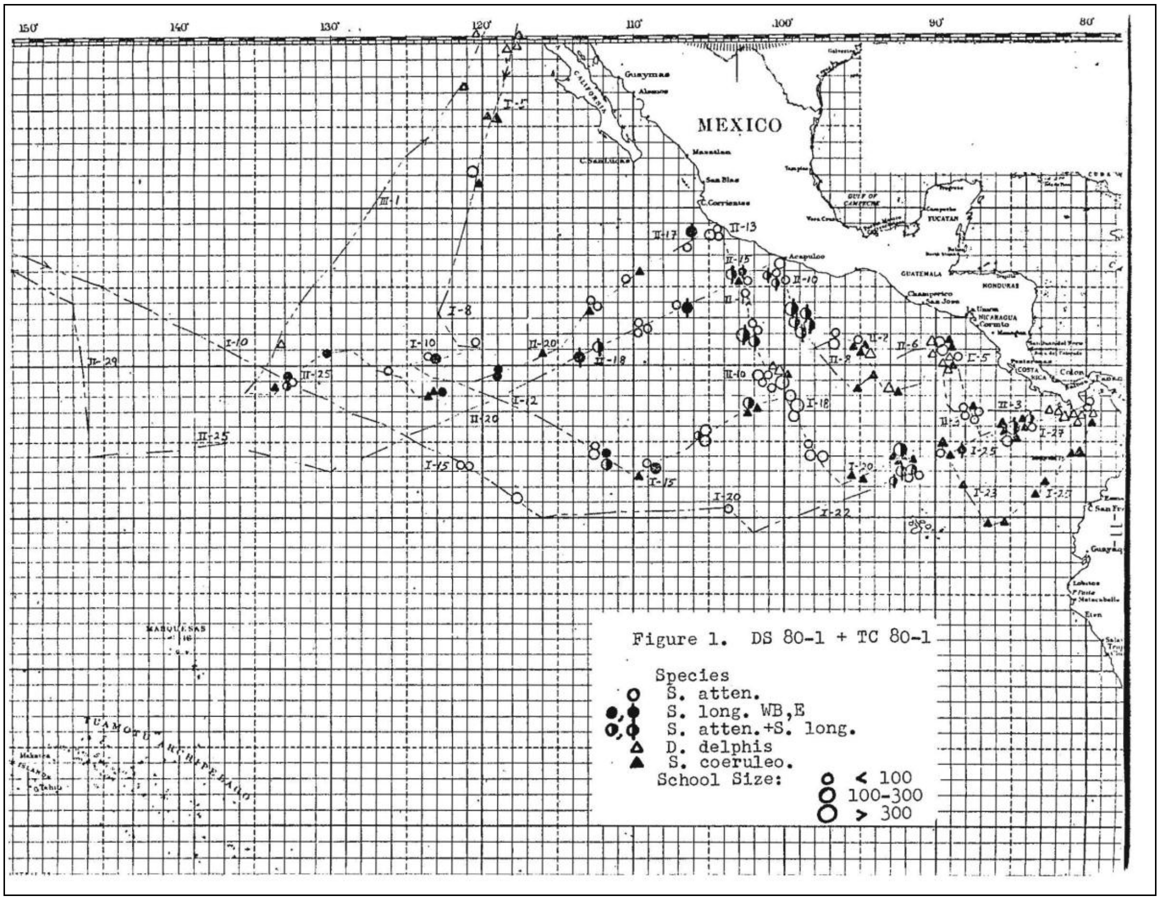
Table 2. Townsend Cromwell (cont'd)

Sightings per Day by Species

Date	Bft Sea State	Delphinids: Stenella attenu.	S. longi WB	S. longi E	S. longi UnID	Stenella coeruleo.	Delphinus	Grampus	Globiceph.	Tursiops	Steno	Other	UnID	Whales: Sei (S)	Bryde's (B)	Other Rorqual	Mesoplod.	Other Ziphiid	Sperm	Other	UnID
2-23-80	3-4-5																				
2-24	4-3									1			2			1-S/B		1-Z			1
2-25	3-4											1-Ps									
2-26	3-4																		1		
2-27	3-5-3																1				1
2-28	4-5																				
2-29	6																				
3-1-80	5																				
3-2	5-4												1								1
3-3	6-5																				
3-4	2-1-2	2							1		1		1						1	1-HB	
3-5	4-7	1																		1-HB	

Ps = Pseudorca Z = Ziphius

Appendix 2Q. Cruise report for SWFSC Cruises 0598 and 0599. (Continued)



Appendix 2R. Cruise report for SWFSC Cruise 0642.

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

CRUISE REPORT

Report of Equatorial Cetacean Survey in the Eastern Pacific
R/V Oceanographer

PROJECT: Equatorial Cetacean Communities

VESSEL: NOAA Ship Oceanographer

CRUISE PERIOD: March 21 - April 19, 1980

ITINERARY: March 21, 1980 Depart San Diego
April 19, 1980 Arrive Kwajalein, Marshall Islands

OBJECTIVES:

1. To obtain information on the species and abundance of marine mammals in the eastern and central equatorial Pacific.

2. To obtain data on oceanographic correlates of marine mammal distribution in the study area.

3. To study population abundance, species composition, and stock ranges of dolphin species relative to eastern Pacific populations

4. To study the interactions and relationships of seabirds and fish with dolphins in the different areas surveyed.

5. To test the feasibility of using a "ship of opportunity" for marine mammal survey work.

OPERATIONS:

Marine mammal and seabird observations began on March 22 when binoculars were mounted on the Oceanographer. Watches were maintained daily throughout the cruise until the ship arrived at Kwajalein on the morning of April 19. These watches typically ran through all daylight hours while the vessel was underway, except when both observers broke for meals or rest and during regular stops for oceanographic work. Using these methods approximately 2452 track miles were searched. Vessel speed ranged from 10 to 15 knots but was usually 14 knots.

The marine mammal search utilized 25 x 150 mm Fuji binoculars. One pair each was mounted port and starboard on the flying bridge. The height of the glasses to sea level was 48'; distance to the horizon from that position was approximately 8.0 miles on a calm day. The vessel did not alter course or speed to investigate marine mammals so that all sightings were made in passing. (Two exceptions are noted in the records).

Bird and mammal sighting logs, an effort log and an hourly watch log (recording sighting conditions) were maintained daily. In addition scientific personnel involved with other projects or ship's survey technicians supplied data from hourly XBT launches, CTD stations, weather observations, and chlorophyll fluorescence monitoring.

RESULTS:

Cetaceans (Table 1).

A total of 192 separate cetacean schools was seen. Fifty-six percent were identified and 70% were at least partially identified. The sighting rate, up to 34 schools per 100 miles searched was similar to that obtained in many areas of the "porpoise-tuna" fishing grounds in the ETP, indicating that equatorial waters can support, at times, a rich cetacean community. The daily sightings are summarized in Table 1 which shows species identification and school size. Rorquals, especially the identification possibility, B. borealis/B. edeni, and Globicephala were widespread and relatively abundant. Other species were localized: Ziphius cavirostris and Kogia (probably K. simus) in the eastern portion of the area surveyed, and Lagenodelphis hosei and Peponocephala electra in the central portion. The latter two species were the only large schooling dolphins relatively abundant on the equator. Globicephala were usually rafting, without accompanying birds while Pseudorca crassidens were often with birds and usually very active. Unlike in the tropical waters of the ETP, few seabirds were associated with cetaceans. This cruise confirmed the behavioral differences between Feresa and Peponocephala noted on previous trips and also the differences between equatorial and tropical waters with respect to cetacean communities and species interactions.

Sea Birds

The most striking aspect of the marine avifauna was the passage of northbound migrants from their southern hemisphere resting grounds. Cook's and Mottled Petrals, Sooty and Slender-billed Shearwaters were most prominent.

Sooty Terns were by far the most abundant bird seen the entire trip, especially from April 5 on (134°W+) when large numbers were often seen following tuna schools. Large mixed feeding flocks associated with dolphins and tuna, so typical in the eastern tropical Pacific, were almost entirely absent along the equator, even in areas of abundant sooty terns. Boobies and frigatebirds, both characteristic of eastern Pacific feeding flocks (and heavy feeders on flying fish), were present in only small numbers and then rarely associated with tuna or cetacea.

Appendix 2R. Cruise report for SWFSC Cruise 0642. (Continued)

RECOMMENDATIONS:

The results of this cruise demonstrate that trained observers with high-powered binoculars mounted on vessels of opportunity can be very effective (as well as economical) in obtaining data on distribution and relative abundance of marine mammals. An average of 6.6 sightings/day were logged during the cruise with successful identifications for over 50% of the sightings. (Notoriously difficult-to-separate species groups or species pairs, e.g. Mesoplodon or Peponocephala/Feresa were considered "successful" identifications). It is, therefore, highly recommended that future observations from other vessels traveling in areas of interest be given consideration for studying distribution, relative abundance, and population characteristics. Specific suggestions for future surveys include:

1. A minimum of 2 observers (3 would be better) is necessary to handle paper work and still maintain survey effort comparable to regular porpoise assessment cruises that have been conducted in the eastern Pacific.

2. It would be highly beneficial if 1 hour/day could be made available for diverting the vessel to identify porpoise. During this Oceanographer cruise the Stenella/Delphinus category was one of the most difficult to differentiate species-wise. A little extra time to look at close or large aggregations would have increased success with this group considerably. This time could be expended opportunistically and carried out so as not to interfere with other operations on the vessel.

SCIENTIFIC PERSONNEL:

Robert Pitman, N.M.F.S.
Scott Sinclair, N.M.F.S.

Prepared by:

David Au	D. Au for	D. Au for
David Au, SWFC	Robert Pitman, SWFC	Scott Sinclair, SWFC
Op. Res. Analyst	Biological Tech.	Biological Tech.

Date: July 23, 1980

Approved by:

Izadore Barrett
Izadore Barrett
Center Director

7/25/80
Date

Appendix 2R. Cruise report for SWFSC Cruise 0642. (Continued)

Table 1. Summary of Sightings by Species and School Size

Date	Miles searched	Noon Position Lat.	Long.	Beaufort	UNID Delphinid	Stenella	Globicephala	Grampus	Lageno./Pepono.	"Blackfish"	Other	UNID Whale	Rorqual	Physeter	Kogia	Ziphiid	Mesoplodon	"Cetacean"
3-23-80	141.6	22-17N	114-06W	5-4							200-D 175-D 55-D		1-B 1-B					
3-24-80	121.8	17-04N	112-21W	3	5	40-C					75-D		1/SB					
3-25-80	140.6	11-53N	110-38W	5-4	5 10 25							1 1						
3-26-80	112.8	7-28N	110-00W	4	50	25-C 15-C 10-C												
3-27-80	108.0	3-01N	110-02W	4-3	1						12-PS							
3-28-80	51.1	D-00	110-11W	2		33-C						1	1/SB 1					
3-29-80	56.6	0-20S	111-10W	1-0	25	60-C	25 3	8		35 10 10	3-S		1/SB		5 1 1 1 3	3-Z 3 4-Z 4-Z		
3-30-80	96.2	0-00	112-29W	2-0				12				1	2/SB 1		1 2 1	5-Z 1 2 4-Z 3-Z 1-Z		
3-31-80	43.8	0-02N	115-35W	2	6 6		10									1		1
4- 1-80	57.5	0-03N	117-34W	4	1 1												2	
4- 2-80	111.7	0-01N	120-50W	3-2	25 5 75 2 8 12		25	3 2 6 1D		10	15-S 18-S	1	1 1 1 1	10	1	3 2	1	1 25
4- 3-80	0	0-00	125-39W	-	182													
4- 4-80	69.0	0-02N	130-01W	2	187		20 8	12			13-PS		1/SB 1	12				1
4- 5-80	126.3	0-02S	134-06W	2	70 35	115a/ℓ	15 35 25 23					25	1 3 1 1 2	4 10				

Species Abbreviations: D = Delphinus; O - Orsinus; C = S. coeruleoalba; T = Tursiops; A = S. attenuata; ℓ = S. longirostris; B = B. musculus; S/B = Sei/Bryde's; PS = Pseudorca; S = Steno; Z = Siphius; L = Lagenodelphis; P = Peponocephale

Appendix 2R. Cruise report for SWFSC Cruise 0642. (Continued)

Table 1. (Contd) Samples of Sightings by Species and School Size

Date	Miles searched	Noon Position Lat.	Long.	Beaufort	UNID Delphinid	Stenella	Globicephala	Grampus	Lageno./Pepono.	"Blackfish"	Other	UNID Whale	Rorqual	Physeter	Kogia	Ziphiid	Mesoplodon	"Cetacean"
4- 6-80	110.3	0-00	137-30W	2	25 1 5	102-A	7 25 5 20 15 18		525L 225L 150L		1T		1 1 2 S/B 2 1	33				1
4- 7-80	118.7	0-03S	140-53W	2-3-2	20 45				350L/P 125L 250L/P 175L/P	18	10-S		2 S/B 2					
4- 8-80	31.9	0-02S	145-02W	3-4									1					
4- 9-80	94.9	0-01S	149-38W	3-4-3			12 25				20S	1						
4-10-80	98.9	0-00	152-51W	2-3		20-C	10		100L 400P		12PS 5PS		1 1 3 S/B					1
4-11-80	105.1	0-00	156-15W	4			20 28						1 S/B 1 1 S/8					
4-12-80	89.4	0-01S	159-57W	4					175P								1	
4-13-80	95.2	0-00	164-58W	4			5	8										
4-14-80	93.9	0-01S	169-23W	4										3				
4-15-80	118.2	0-01N	173-46W	3-2	5 12	62-a	15											
4-16-80	100.8	0-00	178-52W	3-2														1
4-17-80	112.4	2-04N	176-52E	2-3	100	130ℓ 20ℓ							1	7 3 5				
4-18-80	44.8	5-11N	172-19E	4	1													

Appendix 2S. Cruise report for SWFSC Cruise 0646.

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

CRUISE REPORT

R/V David Starr Jordan - COASTAL MARINE MAMMALS

PROJECT: Coastal Marine Mammals

VESSEL: R/V David Starr Jordan Cruise 80-5

CRUISE PERIOD: June 17 - July 11, 1980

ITINERARY: June 17, 1980 Leave San Diego
July 11, 1980 Arrive San Diego

OBJECTIVES:

1. Study major movements and density patterns among marine mammals in nearshore and offshore areas of the California Current.

2. Assess the importance of coastal processes and features to marine mammals.

3. Study satellite imagery as related to mesoscale features and marine mammals.

4. Obtain samples of epiplankton (giant Manta net).

OPERATIONS:

The R/V D. S. Jordan searched for marine mammals along 23 legs in the California Current between Cape Mendocino, California and Vizcaino Bay, Mexico. A 12-hour marine mammal watch was maintained each day except when prevented by bad weather. The marine mammal search used 25 x 150 mm Fuji binoculars. A pair was mounted port and starboard on the flying bridge. The distance to the horizon was approximately 7 miles, and the ship's speed was usually 9-10 knots. The observer teams stood 3-hour watches, interchanged positions (port and starboard) hourly, and each observer was relieved temporarily approximately each half hour. The ship usually approached each mammal school for identification and study.

XBT's were dropped each 6 hours daily. Sea surface conditions were monitored by thermosalinograph.

Surface chlorophyll was monitored continuously along with irradiance, transmittance and color measurements.

Data on meteorological and observer sighting conditions were kept.

Neuston samples using the giant Manta net were taken.

RESULTS:

1. Marine Mammals

There were 156 separate sightings of 20 species of cetaceans and 144 of 4 species of pinnipeds recorded during the cruise. The cetacean sightings are summarized in Table 1 and Figures 1-4.

a. Dolphins

The most frequently encountered delphinid was Delphinus delphis (common dolphin) with 34 sightings. These were widely scattered, being encountered out to the farthest legs offshore. They were locally abundant off Vizcaino Bay, Mexico (Cedros Island). None were seen north of Monterey, California, possibly due to the very bad weather on the offshore tracks off central California. Most schools were small, only 11 being greater than 50 individuals. All but 8 schools approached the ship. Five schools were with feeding birds, 2 with Zalophus californianus (sea lion), 2 with Stenella coeruleoalba (striped dolphin) and one with both Grampus griseus (grampus) and Lissodelphis borealis (northern right whale dolphin). Much individual variation in body coloration was noted including degree of development of flipper and anal stripes, extent of the dorsal cape, and development of the thoracic white patch. Individuals without the patch were seen in offshore waters.

There were 19 sightings of Lagenorhynchus obliquidens (Pacific white-sided dolphin), seen on the nearshore legs and relatively abundant off San Francisco and Vizcaino Bays. All but 2 schools were smaller than 50. Lissodelphis and Grampus were with 2 schools, and 7 schools were associated with birds, mostly sooty and pink footed shearwaters. A color variation in which the white side was replaced by black was seen.

Phocoenoides dalli (Dall's porpoise) was seen 20 times on inshore legs north of the Santa Barbara Basin. Again rough weather may explain why none were seen offshore. The largest school had 7 individuals. Seven schools rushed the ship but most were rolling slowly or apparently unaffected by the ship. One school was with humpback whales and another with Mesoplodon sp.

Grampus griseus (Grampus or Risso's dolphin) was seen 20 times on both inshore and offshore legs off central California. Four schools of 30 or more were seen. Approximately half the schools were moving with great activity. Three approached the ship. Four schools were with Lissodelphis, Delphinus, or Zalophus.

There were 5 sightings of Lissodelphis borealis (northern right whale dolphin) between Cape Conception and San Francisco Bay. School size ranged from 7 to 200. Three schools approached the ship and 3 were associated with Grampus and/or Delphinus.

Other delphinids seen were Tursiops truncatus in the Southern California Bight, Phocoena phocoena near Humboldt Bay, Globicephala sp. off Mexico, and Orcinus orca north of San Francisco.

b. Whales

The most frequently seen whale was Balaenoptera musculus (blue whale) of which there were 16 sightings involving 38 individuals. All were encountered south from the vicinity of Pt. Conception. One was approximately 200 miles offshore. Another was with a 25-foot calf. The size and behavior of these whales again raised the possibility that they were of the brevicauda subspecies.

There were 8 sightings involving 19 individuals of B. physalus (fin whale). Most were along the San Nicholas-Tanner-Cortez Bank ridge. Three B. edeni (Bryde's whale) were seen in offshore waters off Southern California and 4 B. acutorostrata (minke whale) were seen near Vizcaino Bay.

Additionally, the humpback whale Megaptera novaeangliae was seen 9 times in nearshore waters north from the Channel Islands and the grey whale (Eschrichtius robustus) was seen outside Humboldt Bay. Physeter macrocephala (sperm whale) was seen twice in the offshore, oceanic waters.

Ziphiid whales were encountered 9 times. These included 2 sightings of Ziphius cavirostris and one of the more slight Mesoplodon sp. Additionally, there were 2 sightings, involving 19 individuals, of Berardius bairdii. These latter were 35-45 feet in length, greenish grey-brown, and often with scarring or scratch marks. They had low puffy blows, low rounded dorsal fins, and relatively long beaks. They performed 20-minute dives, and also exhibited rafting, tail slapping, side-rolling, and bunching-up behavior. Berardius were encountered north from the vicinity of San Francisco Bay.

c. Pinnipeds

Zalophus californianus (California sea lion) was sighted 89 times, primarily over the Santa Barbara Basin and off Vizcaino Bay. Other less frequently seen species were Mirounga angustirostris (northern elephant seal), Callorhinus ursinus (northern fur seal) and Phoca vitulina (harbor seal). There were only 2 pinniped sightings on the offshore cruise legs, where the weather was rough.

2. Seabirds

Pink footed shearwaters (Puffinus creatopus) and especially sooty shearwaters (Puffinus griseus) were abundant over nearshore legs, especially north from the vicinity of Cape Conception. These species often occurred in feeding flocks, sometimes in association with cetaceans or pinnipeds. Numerous other species were seen including relatively large numbers of Cook's petrels (Pterodroma cooki) off Southern California and Mexico.

3. Environment

Rough seas prevailed during this cruise. Beaufort sea state reached to greater than 3 on all but 2 days and was up to Beaufort 7 on one day. Fog was also encountered off Southern California.

Marine mammals were more abundant in the inshore waters of the California Current than in the neighboring oceanic waters. Usually areas exhibiting increased chlorophyll levels and lower temperatures, indicating increased mixing and upwelling, also had increased mammal sightings. These areas were usually near seamounts, escarpments, or island terraces, though the relationship to bottom topography was not direct. Neuston collected at night showed increased catches of krill in some of these same areas, and there were increased sightings of rorquals there. Offshore seamounts did not show increased chlorophyll levels, and there was no indication that they attracted marine mammals.

Four satellite images, with ship track not obscured by clouds, were collected at the Scripps Remote Sensing Facility during the cruise. Three of these were sequential and show a variety of mesoscale features that are pertinent to the cruise results.

SCIENTIFIC PERSONNEL:

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P. Dustan, S.I.O., Senior Scientist
R. Pitman, SWFC, Biological Technician
J. Cotton, SWFC, Biological Technician
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Prepared by:

David Au
David Au, SWFC
Chief Scientist

8-14-80
Date

Approved by:

for Izadore Barrett
Center Director

8/16/80
Date

Appendix 2S. Cruise report for SWFSC Cruise 0646. (Continued)

-5-

Table 1 - Summary of Sightings (# schools)

		DOLPHINS								WHALES							
Date	Bft. Sea State	Delphinus	Lagenorhyn.	Phocoenoid.	Lissodelphis	Grampus	Tursiops	Globiceph.	other	Eschrichtius	B. musculus	B. physalus	other Rorqual	Megaptera	Physeter	Ziphiid	other
6-18-80	1-5	2	1								2	1	1				
6-19	2-5						1				3	6	2				
6-20	1-6	1					1				1						
6-21	2-6			3					1-U		1			1		1	
6-22	3-5		1		1	3					1			1			2-U
6-23	5		2	1	2	3			1-U			1				1	
6-24	2		9	7	1	4			1-U					1		1-Z 1-B	
6-25	2-3		1	4		4			1-O					1		2-M	
6-26	0-4			3		1			1-U 1-Ph	1						1-B	
6-27	6-7			1													
6-28	6															1-M	1-U
6-29	4-5	2		1		3							1			1Z	
6-30	3-4	7			1	2									1		
7-1	3-5	2									1		1-Br		1		
7-2	2-3	1															
7-3	3-4	1											1-Br				
7-4	5	1															
7-5	5	2							1-St		2		1				
7-6	3-5																
7-7	1-4	11	2						1-St		1		3-M				
7-8	2-5	2						1					1-M			1	1-U
7-9	4-6	1									3						
7-10	4-5	2	1						1-U		1		1				1-U

U = Unidentified Ph = Phocoena Br = Bryde's Z = Ziphius M = Mesoplodon
O = Orsinus St = S. coeruleo. M = Minke B = Berardius

Appendix 2S. Cruise report for SWFSC Cruise 0646. (Continued)

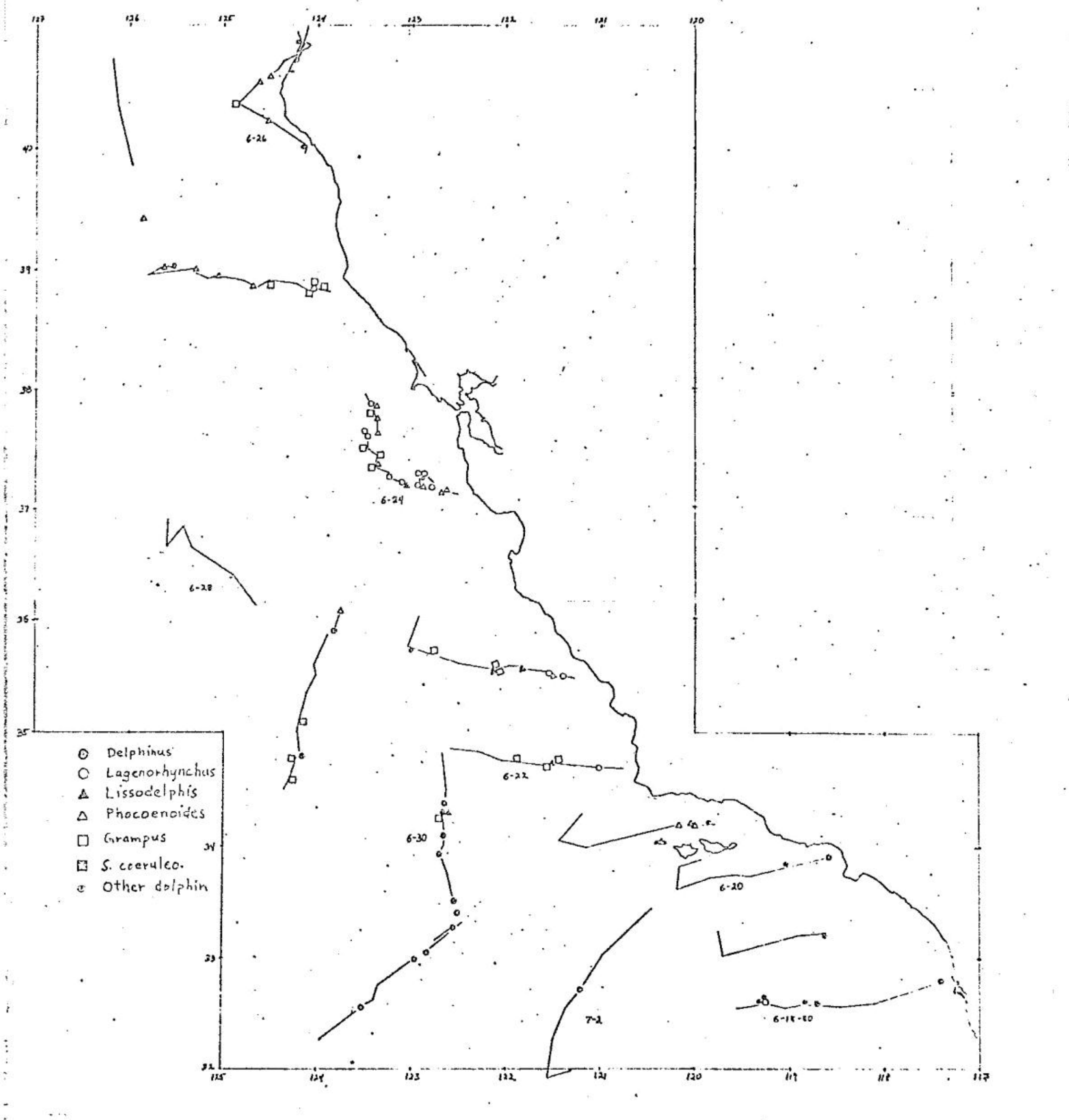


Fig. 1 Delphinids

Appendix 2S. Cruise report for SWFSC Cruise 0646. (Continued)

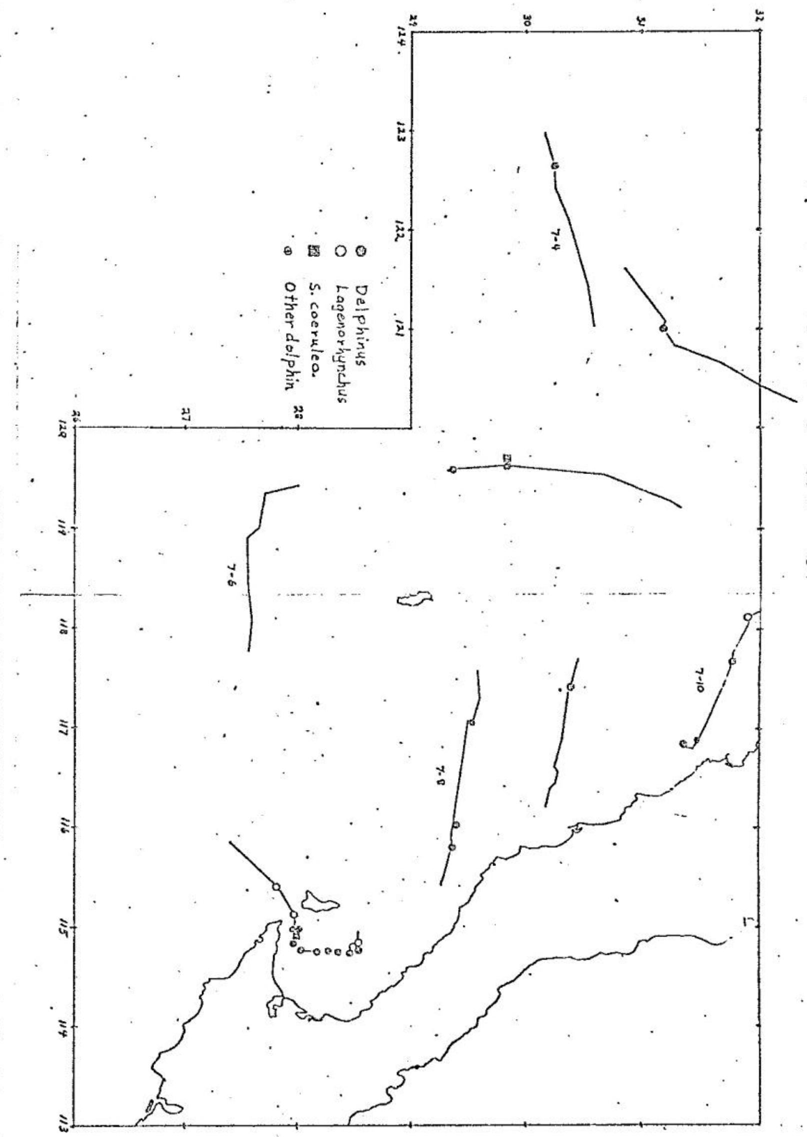
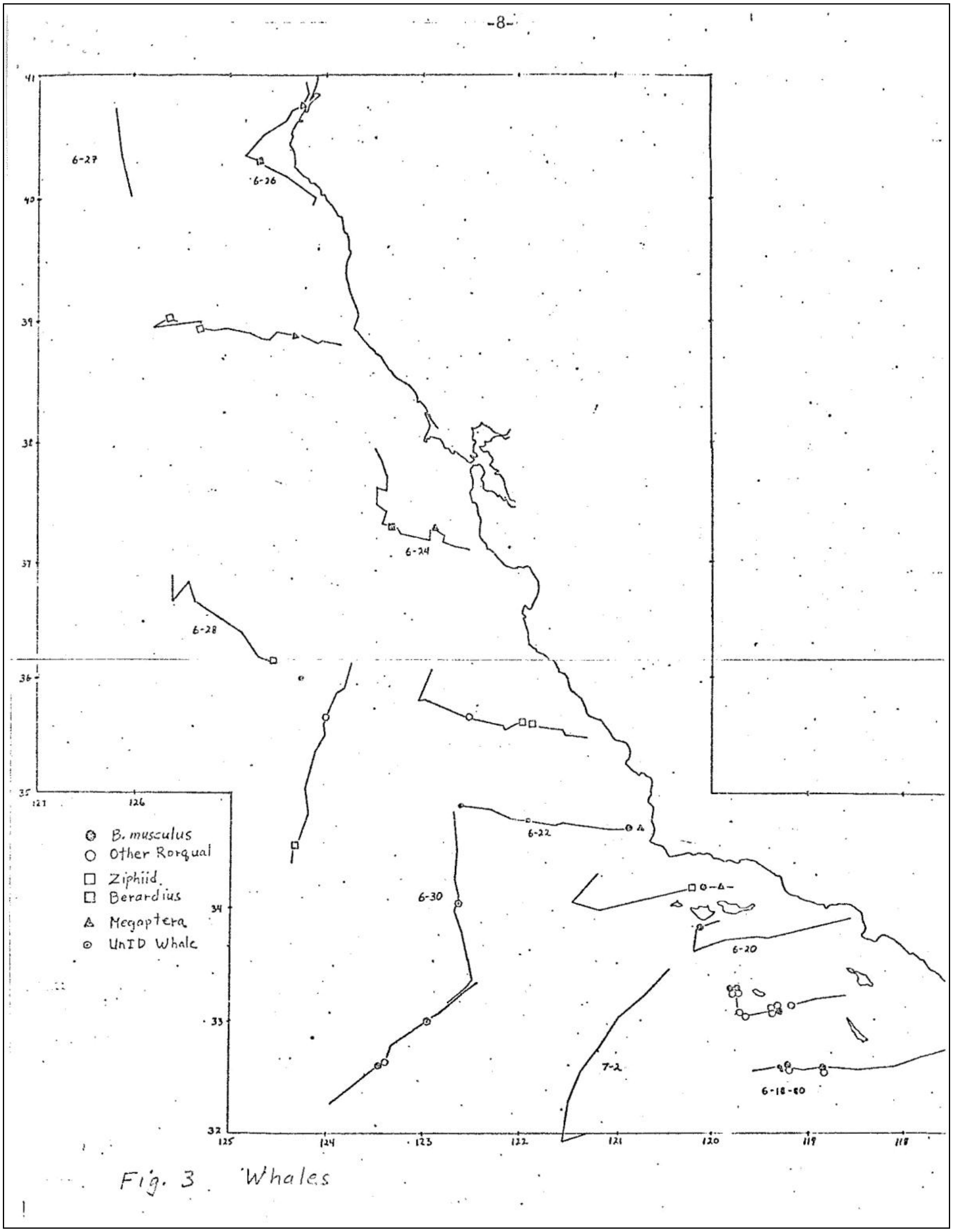


Fig. 2 Delphinids


-8-
B. musculus
Other Rorqual
Ziphiid
Berardius
Megaptera
UnID Whale
6-27
6-26
6-24
6-28
6-22
6-30
6-20
7-2
6-18-20
Fig. 3 Whales

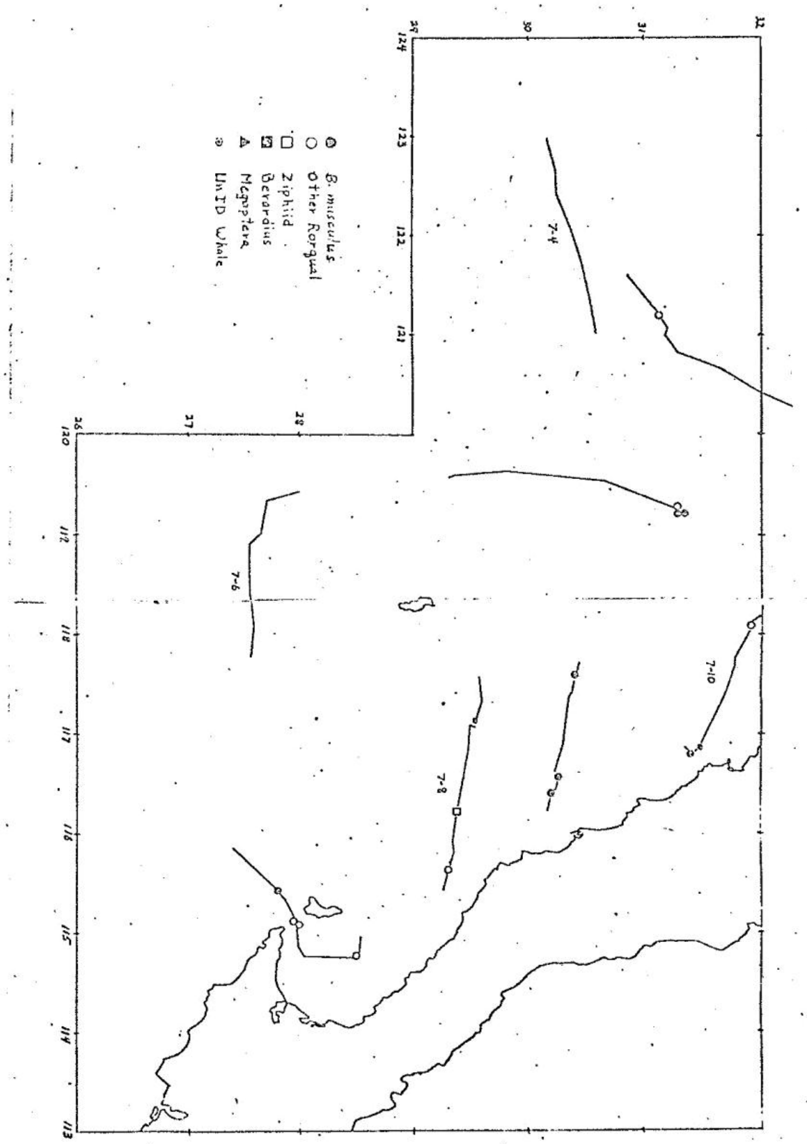

B. musculus
Other Rorqual
Ziphiid
Berardius
Megaptera
UnID Whale
7-4
7-6
7-8
7-10

Fig. 4 Whales

Appendix 2T. Cruise report for SWFSC Cruise 0648.

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

CRUISE REPORT

Report on Cetacean Studies Conducted from
R/V Researcher (PC-648)

PROJECT: EPOCS

VESSEL: NOAA Ship Researcher

CRUISE PERIOD: July 21 - September 25, 1980

ITINERARY:

July	21, 1980	Depart Miami
July	25	Arrive Panama
July	28	Depart Panama
August	21	Arrive Manzanillo
August	25	Depart Manzanillo
September	18	Arrive Panama
July	21	Depart Panama
September	25	Arrive Miami

OBJECTIVES:

1. The primary objective of this cruise was to obtain certain physical oceanographic measurements in support of EPOCS (E. Pacific Ocean Climate Study).

2. On a noninterference basis, SWFC observers were to obtain information on cetaceans along the cruise track. The purpose was to:

a. obtain further information on seasonal aspects of cetacean distributions.

b. obtain data on oceanographic correlates to cetacean communities.

c. obtain further data for defining the extent of the dolphin-tuna association.

OPERATIONS:

The R/V Researcher left Panama for the equator, via the Galapagos Islands, to begin its equatorial and longitudinal transects. The equatorial transect was on the equator between 95° and 110°W. Next a transect between 3°S and 11°N along 110°W was conducted, followed by a stop at Manzanillo. This longitudinal transect was repeated on the return trip southward. Another longitudinal transect was conducted between 3°S and 7°N along 102°30'W longitude. The ship then returned to Panama, proceeding eastward along $7^{O}N$ latitude. A short transect was also conducted between $2^{O}S$ and $2^{O}N$ at $95^{O}W$.

The marine mammal search utilized 25 x 150 mm Fuji binoculars. One pair each was mounted port and starboard on the flying bridge. Watches were maintained during daylight hours whenever the ship was underway. The ship did not alter course or speed when a cetacean sighting occurred.

RESULTS:

There were 32 sightings of dolphins and 5 of whales along the equatorial transect. Among the dolphins there were 19 identified as Stenella coeruleoalba or Delphinus delphis, but only 3 of Stenella attenuata or Stenella longirostris. Surface feeding tunas with associated birds were rare. The dominant birds on this section of the equator were storm petrels and white winged petrels.

North of the equator there were 44 sightings of dolphins and 19 of whales. The sighting rate for dolphins was less than half of that along the equator. The first major sightings (Stenella longirostris and S. coeruleoalba) occurred at ~$5^{O}N$, $110^{O}W$ in an area of frontal activity that marked the northern edge of a transition region between equatorial and tropical surface waters. The next day at $7^{O}N$ a large school of S. attenuata with associated birds and tuna, the first for this trip, was encountered. The qualitative changes in fauna with changes in surface water masses were rather striking. The transition areas north of the equator appeared relatively barren. But upon entry into the warmer tropical surface water with its distinctive thermal structure, S. attenuata and S. longirostris (spotted and spinner dolphin) in association with tuna and birds began appearing. There was also a dramatic increase in numbers of flying fish, and in the shearwaters, petrels, boobys, and terns, i.e. bird species that often follow surface feeding tunas and dolphins.

These observations from the R/V Researcher, support previous studies that suggest (1) that the eastern equatorial region is an important area for S. coeruleoalba and D. delphis but does not support extensive S. attenuata or S. longirostris populations or dolphin-tuna associations, (2) that the dolphin-tuna association is primarily a feature of the faunistic community occurring in the tropical surface waters of the ETP, and (3) that seasonal shifts in surface waters can affect the distribution of cetaceans and determine where dolphin-tuna associations will occur.

Appendix 2T. Cruise report for SWFSC Cruise 0648. (Continued)

SCIENTIFIC PERSONNEL:

Robert Pitman, National Marine Fiserhies Service
M. Scott Sinclair, National Marine Fisheries Service

Prepared by:

David Au

David Au, SWFC	Date 11/10/80
Operations Research Analyst

Approved by:

Izadore Barrett

Izadore Barrett, SWFC	Date 11/12/80
Center Director

Appendix 2U. Cruise report for SWFSC Cruise 0687.

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Southwest Fisheries Center
National Marine Fisheries Service
La Jolla, California 92038

CRUISE REPORT

Report on Cetacean Studies Conducted From
R/V Oceanographer (PC-687)

PROJECT: EPOCS

VESSEL: NOAA Ship Oceanographer

CRUISE PERIOD: January 20 - April 1, 1981

ITINERARY:

January	20, 1981	Depart Seattle
January	24	Arrive San Diego
January	25	Depart San Diego
February	18	Arrive Acapulco
February	23	Depart Acapulco
March	24	Arrive San Diego
March	27	Depart San Diego
March	28	Arrive Monterey
March	29	Depart Monterey
April	1	Arrive Seattle

OBJECTIVES:

1. The primary objective of this cruise was to obtain oceanographic measurements in support of the Eastern Pacific Ocean Climate Study (EPOCS).

2. On a noninterference basis, SWFC observers were to collect information on cetaceans along the cruise track. The purpose was to:

a. Obtain further information on seasonal aspects of cetacean distributions.
b. Obtain data on oceanographic correlates to cetacean communities.
c. Obtain furtner data for defining the extent of the dolphin-tuna association.

OPERATIONS:

The R/V Oceanographer arrived from San Diego at the approximate position 12°N, 110°W, then started its meridional transect southward along 110°W to 3°S, 110°W. The ship then retraced its route northward along 110°W to the starting point at 12°N, 110°W, then proceeded to Acapulco for refueling. From Acapulco the ship repeated its route to the equator and southward to 7°S, 110°W. Returning northward along the same route to 12°N, 110°W, the ship then departed for San Diego and Seattle.

The marine mammal search utilized 25 x 150 mm Fuji binoculars. One pair was mounted port and starboard on the flying bridge. Watches were maintained during daylight hours whenever the ship was underway. The ship did not usually alter course or speed when a cetacean sighting occurred.

RESULTS:

There were 253 cetacean sightings logged. Of these 170 were identified. The most frequently seen species in the tropics was Stenella coeruleoalba, which occurred in both tropical and equatorial waters.

The first bird-dolphin association of the tropical ocean was seen at $10^{o}51'$N. These associations were encountered southward to 6^{o}N. Boobys, frigates, and wedge-tailed shearwaters that typically flock over tuna and spotted or spinner dolphin (S. attenuata, S. longirostris) schools were involved.

In the equatorial waters between 5^{o}N and 5^{o}S, the species composition of cetaceans changed, and the bird species noted above were essentially absent, being replaced by storm and Pterodroma petrels. No bird flocks were seen in association with dolphins in these waters. The dominant equatorial cetacea were Stenella coeruleoalba, Globicephala sp., and Balaenoptera edeni/borealis.

Between 4^{o}S and 6^{o}S sooty and white terns were very abundant and were associated with surface "school-fish". Only 4 dolphin schools seen were attended by these flocking birds. Physeter macrocephalus was locally abundant between 5^{o} and 6^{o}S.

Spotted and spinner dolphins were encountered mostly in tropical waters and along the approaches to Mexico. However, 4 schools were seen between the equator and 5^{o}S.

These observations provide evidence that the cetacean fauna of the ETP is stratified into distinct communities differing in species make-up and kind of interspecific, trophic association.

Appendix 2U. Cruise report for SWFSC Cruise 0687. (Continued)

SCIENTIFIC PERSONNEL:

Robert Pitman, NMFS
James Cotton, NMFS

Prepared by:

David Au
David Au, SWFC
Operations Research Analyst

May 18, 1981
Date

Approved by:

Izadore Barrett
Izadore Barrett, SWFC
Center Director

5/21/81
Date

Appendix 2V. Cruise report for SWFSC Cruise 0716.

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Southwest Fisheries Center
National Marine Fisheries Service
La Jolla, California 92038

CRUISE REPORT

Report on Cetacean Studies Conducted from
R/V Oceanographer (PC - 716)

PROJECT: EPOCS

VESSEL: NOAA Ship Oceanographer

CRUISE PERIOD: May 19 - July 29, 1981

ITINERARY:

ITINERARY:	May 19, 1981	Depart Seattle
	May 23	Arrive San Diego
	May 25	Depart San Diego
	June 23	Arrive Panama
	June 28	Depart Panama
	July 29	Arrive Seattle

OBJECTIVES:

1. The primary objective of this cruise was to obtain oceanographic measurements in support of the Eastern Pacific Ocean Climate Study (EPOCS).

2. On a noninterference basis, SWFC observers were to collect information on cetaceans along the cruise track. Their purpose was to:

a. Obtain further information on seasonal aspects of cetacean distribution.
b. Obtain data on oceanographic correlates to cetacean communities.
c. Obtain further data on the extent of the tuna-dolphin association.

OPERATIONS:

The R/V Oceanographer completed three North-South transects. The first was from 10°N, 110°W to 6.5°S, 110°W. The second was from 1°N, 95°W to 2°S, 95°W and the third was from 4°S, 85°W to 3°N, 85°W.

After refueling in Panama, the ship did an equatorial transect from 85°W to 145°W. Following its completion, the Oceanographer returned to Seattle.

The marine mammal search utilized 25x150 mm Fuji binoculars. A pair was mounted port and starboard over the flying bridge. Standard watches were maintained during daylight hours whenever the ship was underway. The ship did not usually alter course or speed when a cetacean sighting occurred.

RESULTS:

There were 352 cetacean sightings logged. Of these, 230 schools were identified. The most frequently seen delphinid school was that of the common dolphin (38 schools), followed by striped dolphin (28) and pilot whale (22). The most frequent whale was the sperm whale (33), followed by sei/Bryde's whales (16).

Sixteen spotted and spinner dolphin schools were seen near Clipperton Island and in equatorial and coastal waters. Cetaceans were not seen in the Equatorial Counter Current south of Clipperton Island, and neither were the flocking birds that indicate their presence. Bird flocks were encountered in these latitudes farther west (140°-145°W), but heavy weather prevented identification of the associated cetacean species.

The characteristic cetaceans of equatorial waters were seen on the equatorial transect. These were the common dolphin (especially near the Galapagos Islands), striped dolphin, Fraser's dolphin, sperm whale, pilot whale, and sei/Bryde's whale. Storm petrels and southern pterodromas were the main bird species. There was little sign of surface tunas.

A review of the results of the cetacean observations on this and previous EPOCS cruises is being prepared.

SCIENTIFIC PERSONNEL:

Robert Pitman, NMFS
James Cotton, NMFS

Prepared by:

David Au, SWFC
Operations Research Analyst

10/7/81
Date

Approved by:

Izadore Barrett, SWFC
Center Director

10/7/81
Date

Appendix 2W. Cruise report for SWFSC Cruises 0798 and 0801.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Southwest Fisheries Center
National Marine Fisheries Service
La Jolla, California 92038

CRUISE REPORT

VESSEL: R/V *David Starr Jordan* DS 82-04 (154) and DS 82-05 (155).

Cruise 154:

ITINERARY:

Leg I (Sighting methodology)
Departed Tiburon, CA April 5, 1982
Arrived Long Beach, CA April 12, 1982

Leg II (Cetacean Pilot Whale survey)
Departed Long Beach, CA April 12, 1982
Arrived San Diego, CA April 21, 1982

Leg III (Sighting Methodology)
Departed San Diego, CA September 13, 1982
Arrived San Diego, CA September 16, 1982

OBJECTIVES

(1) To develop and test technology to improve accuracy of sighting angles and distances of marine mammals from a ship (Legs I and III).

(2) To survey marine mammals in the California bight and to calibrate pilot whale density estimates from ship sightings made simultaneously with aerial sightings (Leg II).

(3) To conduct mid-water trawls for rockfish, anchovy and squid for collection of otoliths/beaks for aging studies (Leg II).

(4) To collect ground truth environmental data for comparison to satellite imagery (Legs I and II).

(5) To investigate vocalization patterns of marine mammals in the California bight (Leg III).

PROCEDURES AND RESULTS:

Objective 1. The accuracy of five methods for measuring angles and distances of marine mammals to the ship was compared (Legs I and III). These methods were (a) visual estimates, (b) hand-held calipers (Heinemann, 1981)[1], (c) binocular eye-piece reticles and 360°-graduated washer system, (d) computer assisted sighting technique (CAST) system and (e) laser range finder. Distances and angles to stationary (buoys) and moving (small boats) objects were recorded using each method, where feasible, and compared to verified estimates from radar.

The CAST system was not fully operational during Leg I so comparisons were also made during Leg III and during Leg II of Cruise 155 (discussed below).

Because of mechanical limitations, the hand-held calipers and laser range finder were not suitable for determining distances of objects from the ship, especially for objects that were further than two miles away. The distances between graduations on the calipers were too small to accurately determine distances for objects near the horizon. In addition, in most instances it was impossible to detect animals at great distances from the ship with the unaided eye. The optics in the laser range finder were also too weak to detect a suitable target of animals at great distances. Data were collected comparing the remaining three systems.

Objective 2. Line transect methods (Burnham et al., 1980)[2] were used to survey marine mammals off California (Figure 1). A preliminary summary of numbers of schools-by-species detected from the ship is presented in Table 1. Data also were collected to

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[1] Heinemann, D. 1981. A range finder for pelagic bird censusing. J. Wildl. Manage. 45(2): 489-493.

[2] Burnham, K.P., D.R. Anderson, and J.L. Laake. 1980. Estimation of density from line transect sampling of biological populations. J. Wildl. Manage. Monogr. No. 72. 202 pp.

calculate a ship-to-airplane calibration factor (Oliver and Shay, in preparation)[3] for pilot whale density. Because few pilot whale sightings were made from both platforms, a useful calibration factor could not be calculated.

Objective 3. Six mid-water trawls were completed. Otoliths and beaks were removed from fish and squid, respectively. They will be used to regress otolith and beak sizes with biomass of prey species.

Objective 4. Continuous and discrete sea surface temperature, salinity and chlorophyll content data were collected. Discrete samples were collected every three hours, from 0600-2400 hours. Temperature depth profile data (XBT) were also collected. These data will be compared to satellite imagery of the California Bight area.

Objective 5. Vocalizations of *Tursiops* and *Grampus* were recorded during Leg III. Ship noise prevented recording sounds of animals adjacent to the ship so a small boat was used to record sound patterns of animals away from the ship.

SCIENTIFIC PERSONNEL:

Dr. Rennie Holt, Chief Scientist, NMFS, Legs I-III
Dr. Douglas DeMaster, NMFS, Legs I-III
Dr. Jay Barlow, NMFS, Legs I-III
Mr. Mark Lowry, NMFS, Leg II
Ms. Lisa Ferm, NMFS, Legs I and II
Mr. Michael Scott, IATTC, Legs I-III
Mr. Robert Hopkins, Louis Adamo, Inc., Legs I and II
MR. Kirk Van Allyn, Louis Adamo, Inc., Legs I and II
Mr. Bob Cowan, SIO, Leg II
Ms. Sandy Hawes, SDSU, Leg II
Mr. Mike Allard, Simpact Assoc. Leg III
Ms. Martha Brown, NMFS, Leg III
Dr. Wes Parks, NMFS, Leg III

DISPOSITION OF DATA:

Experimental sighting data (Objective 1), R. Holt
Line transect survey data (Objective 2), R. Holt
Trawl data (Objective 3), D. DeMaster
Environmental data (Objective 4), S. Reilly
Vocalization data (Objective 5), D. DeMaster

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[3] Oliver, C.W. and S. Shay. In preparation. Trip report: Marine mammal aerial survey of the southern California Bight. April 13-15, 1982. Southwest Fisheries Center. Admin Report.

Cruise 155:

ITINERARY:

Leg I:
Departed San Diego, CA May 13, 1982
Arrived Manzanillo, MX June 4, 1982

Leg II:
Departed Manzanillo, MX June 7, 1982
Arrived Honolulu, HI July 7, 1982

Leg III:
Departed Honolulu, HI July 11, 1982
Arrived San Diego, CA August 3, 1982

OBJECTIVES:

(1) To continue development and testing of technology (CAST system) improve accuracy of sighting angles and distances of marine mammals from a ship (Legs I and II).

(2) To investigate density gradients of dolphin populations in areas of the dolphin - tuna fishery in the Eastern Tropical Pacific (ETP) especially along the 10°N latitudinal line (Legs I - III).

(3) To study school structure, behavior, species differences, trophic interactions, and effects of environment of dolphins along the 10°N latitudinal line in the ETP (Legs I - III).

(4) To study species and spatial differences in porpoise swimming speeds and reaction to the ship (Legs I - III).

(5) To investigate stock specific vocalization patterns of ETP cetaceans (Leg II).

(6) To examine the variability of dolphin school size estimates and species identifications among different observers (Legs I - III).

(7) To examine the efficiency of observer performance during various watch lengths (Legs I - III).

PROCEDURES AND RESULTS:

Objective 1. Data to investigate the accuracy of the five sighting methods, described for Cruise 154, were also collected in Legs I and II of Cruise 155. Mechanical malfunctions occurred during both Legs and the experiment was not completed until Leg III of Cruise 154 (Note that Leg III of Cruise 154 occurred after Cruise 155).

Objective 2. Line transect methods were used to investigate density gradients of marine mamals along the 10°N latitude line (Figure 2). A preliminary summary by species of 342 marine mammal sightings detected during Cruise 155 is presented in Table 2.

Objective 3. During the course of observing each sighting, data were recorded on species composition of the school, the presence and identification of other associated species, conspicuous behavior of the animals, and environmental. Where possible, these factors were recorded using video photographic equipment operated from under-water viewing ports located on the bow of the ship or from other vantage points aboard the ship.

Objective 4. Estimates of the swimming speed and direction of movement of each school in relation to the ship were recorded at the time of the initial contact. The CAST system also recorded relative positions of the animals as the ship approached the school.

Objective 5. Vocalization patterns of marine mammals were studied during Leg II by Hubbs-Sea World Research Institute biologists using a towed acoustic array. Preliminary results have been prepared by Thomas et al. (1982)[4]. The array detected 84 marine mammal schools during 23 tows over 237 hours of deployment. Analysis of this data will be presented in subsequent reports.

Objective 6. The variability of dolphin school size estimates and species identifications among the six observers was studied. Three of the observers had extensive experience as NMFS tuna vessel observers while the other three observers had conducted several research vessel cruises. Each observer recorded independent school size estimates and species identifications.

Objective 7. The optimal time span that an observer can most efficiently search through the 25X binoculars for marine mammal schools was investigated using watch lengths of 1, 2 and 3 hours. A watch was defined as a continuous segment of time that an observer occupied the three duty stations (i.e., left

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[4] Thomas, J.A., S.R. Fisher and L.M. Ferm. 1982. Preliminary results on marine mammal detection using a towed acoustic array in the eastern tropical Pacific. HSWRI Tech. Rept No. 82-144. 14pp.

and right binocular and recorder stations). Two teams of three observers each alternately completed watch periods. Each team member rotated through the three duty stations during each watch period. When observers were not on duty they were generally not assigned additional duties. However, when necessary, they used this time to record descriptions of schools detected while on watch.

SCIENTIFIC PERSONNEL:

Dr. Rennie Holt, NMFS, Chief Scientist, Legs I and II
Dr. Steve Reilly, NMFS, Chief Scientist, Leg III
Mr. Gary Friedrichson, NMFS, Legs I-III
Mr. Steve Grieser, NMFS, Legs I-III
Mr. Richard Lindsay, NMFS, Legs I-III
Mr. Robert Pitman, NMFS, Legs I-III
Mr. Scott Sinclair, NMFS, Legs I-III
Mr. Thomas Tumosa, NMFS, Legs I-III
Mr. Thomas Polacheck, NMFS, Leg II
Mr. Robert Hopkins, Louis Adamo, Inc., Leg II
Dr. Jeanette Thomas, HSWRI, Leg II
Mr. Shelton Fisher, HSWRI, Leg II
Ms. Lisa Ferm, HSWRI, Leg II
Dr. V. Mineev, U.S.S.R., Leg III
Dr. V. Doroshenko, U.S.S.R., Leg III
Mr. Dimitry Abramenkof, NMFS, Leg III

DISPOSITION OF DATA

Environmental data (Objective 3) S. Reilly
Acoustic vocalization data (Objective 5) J. Thomas
All other data, R. Holt

Prepared by: Rennie S Holt — November 1, 1982
Rennie S. Holt — Date
Chief Scientist

Approved by: John F. Carr — 11/1/82
for Izadore Barrett — Date
Director, F/SWC

Appendix 2W. Cruise report for SWFSC Cruises 0798 and 0801. (Continued)

Table 1. Summary of 96 marine mammal schools detected during Cruise 154. Note: totals do not sum to 96 due to occurrence of two or more species in a single school.

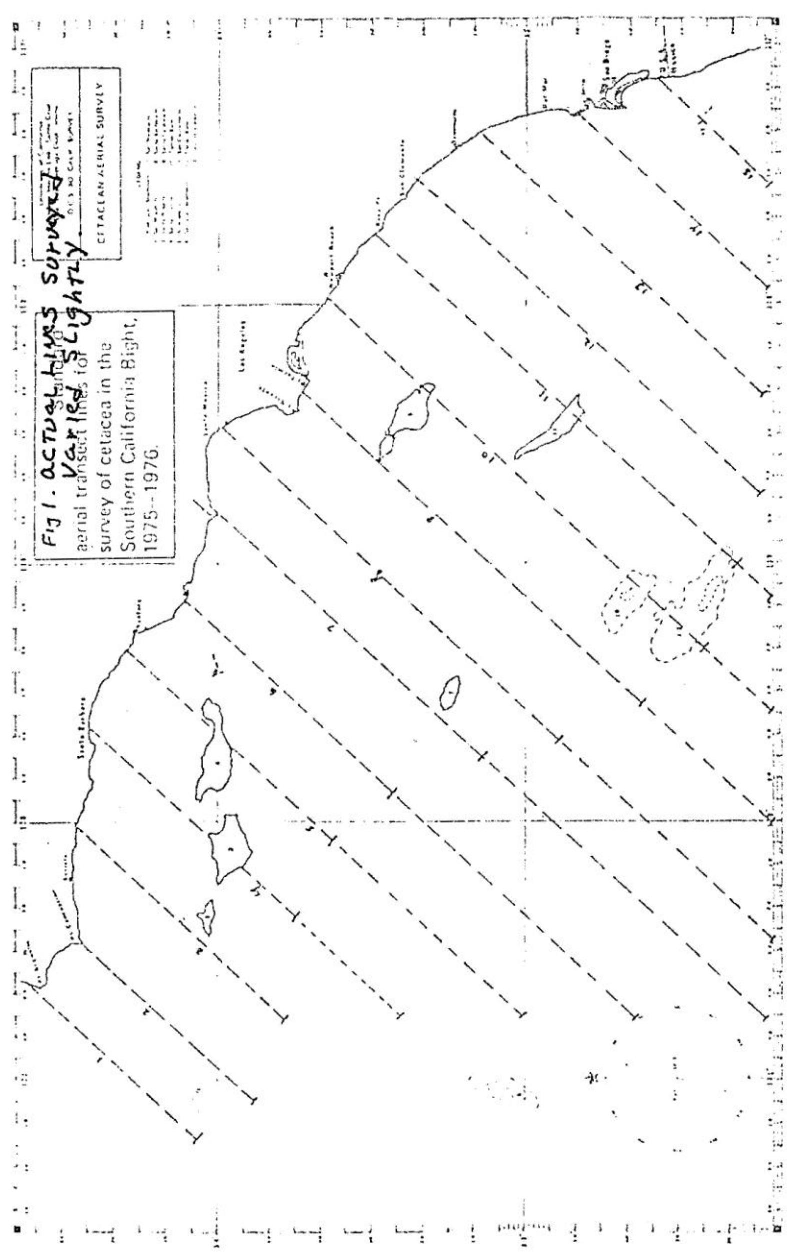
Species	Pure Schools	Mixed Schools
Grampus griseus	10	7
Phocoenoides dalli	16	0
Globicephala sp	2	3
Tursiops truncatus	3	6
Lagenorhynchus obliquidens	8	0
Lissodelphis borealis	10	5
Delphinus delphis	15	2
Orcinus orca	2	0
Unidentified whale	12	0
Unidentified cetacean	6	0
Total	84	23

Table 2: Summary of 342 marine mammal schools by species, school size categories, and species composition detected during Cruise 155. Note: totals do not sum to 342 due to the occurrence of two or more species in a single school.

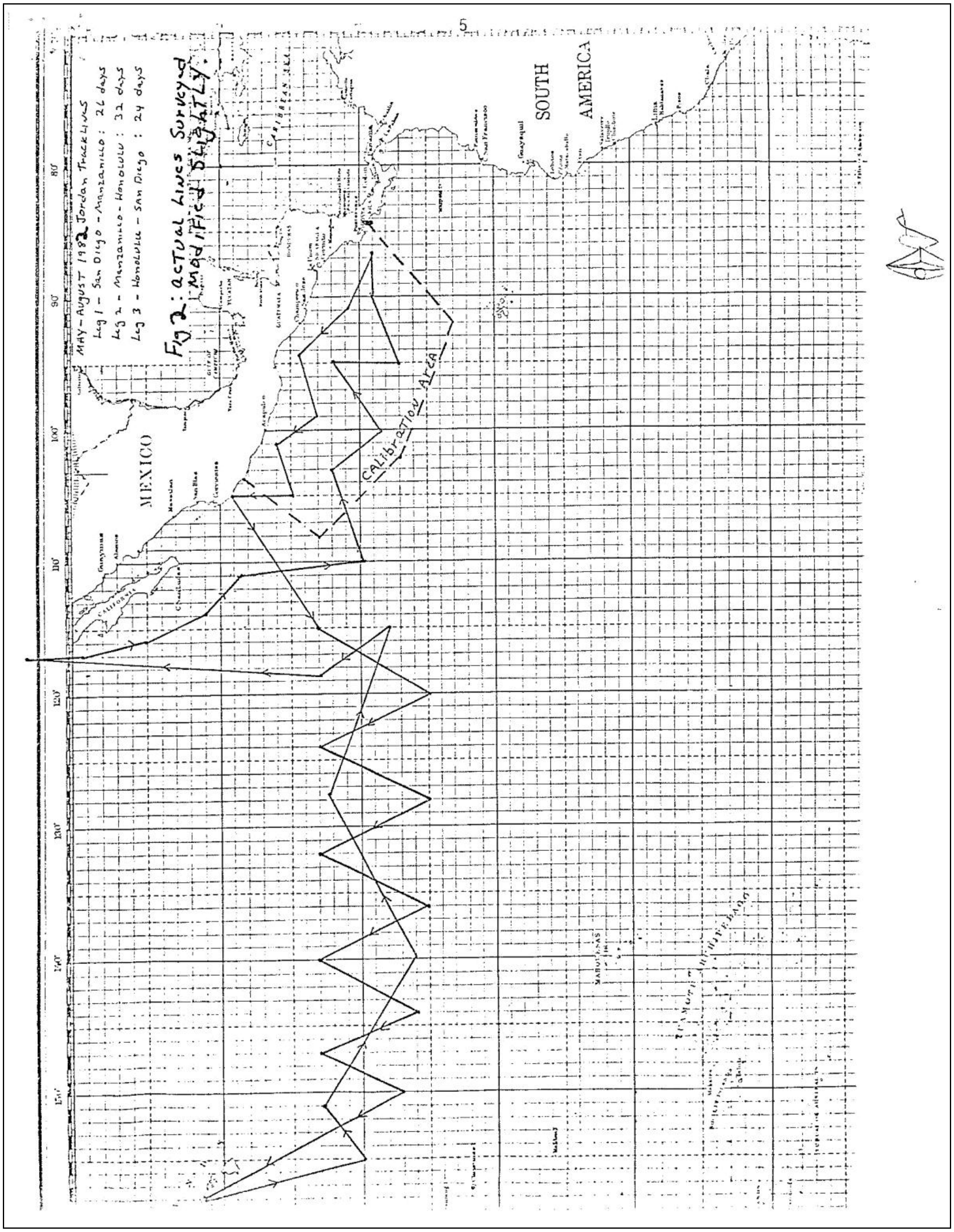
	Pure Schools		Mixed Schools	
Species	School size less than 15	School size 15 or greater	School size less than 15	School size 15 or greater
Stenella attenuata		13	9	38
Stenella longirostris	2	1	6	53
Stenella coeruleoalba	6	20		2
Delphinus delphis		15		
Steno bredanenis	10	3	4	1
Tursiops truncatus	8	3	6	3
Feresa attenuata		2		
Pseudorca crassidens	2		1	
Lagenorhynchus obliquidens	1			1
Grampus griseus	10		5	1
Kogia sp	17			
Orcinus orca	3			
Mesoplodon sp	8	1		
Globicephala sp	11	3	4	2
Ziphius sp		12		
Megaptera novaeangliae		1		
Balaenoptera sp	8			
Physeter macrocephalus	3			
Unidentified porpoise	46	18	7	3
Unidentified small whale	35	1		
Unidentified large whale	20		1	
Total	202	78	47	55

Appendix 2W. Cruise report for SWFSC Cruises 0798 and 0801. (Continued)

6



Appendix 2W. Cruise report for SWFSC Cruises 0798 and 0801. (Continued)



Appendix 2X. Cruise report for SWFSC Cruise 0843.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

CRUISE PERSONNEL

C/o W. Parks (10)

3 May 1983

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Southwest Fisheries Center
National Marine Fisheries Service
La Jolla, CA 92038

CRUISE REPORT

VESSEL: RV David Starr Jordan.

CRUISE: Jordan cruise no. DS 83-01 (160). Marine mammal observer cruise no. 843.

CRUISE DATES: 10 January - 13 April 1983.

PROJECT: Marine mammal assesssment survey.

ITINERARY: LEG 1 Depart San Diego, CA, 12 Jan. 1983. Arrive Callao, Peru, 4 Feb. 1983.

LEG 2 Depart Callao, 7 Feb. 1983. Arrive Papeete, Tahiti, French Polynesia, 6 Mar. 1983.

LEG 3 Depart Papeete, 12 Mar. 1983. Arrive San Diego, 13 Apr. 1983.

See Figure 1.

OBJECTIVES: 1. To survey density, size and species composition of dolphin schools in the area south of the Galapagos Islands and between South America and French Polynesia.

2. To continue to develop and test methodology to improve accuracy of marine mammal sightings.

3. Participating with RV Surveyor, to investigate the reaction of dolphin to the approach of a vessel.

PROCEDURES: Objective 1

The survey area is approximately the southern boundary of the tropical tuna/dolphin fishery in the eastern Pacific Ocean and roughly coincident with the southern boundary of the known ranges of stocks of dolphin associated

1

with this fishery. To enable comparison of data collected from the survey area to data from more northern areas and to data collected in previous years, density, size and species composition of dolphin schools in the central area of the fishery (the "calibration area") was also surveyed.

The survey was conducted by maintaining a visual watch using two 25 power binoculars mounted on the two sides of the flying bridge of the Jordan. The binoculars were mounted on pedestals at a height of approximately 35 feet above the water giving a maximum ship-to-horizon sighting distance of approximately 6 nautical miles.

Watch was stood by two teams of three observers each rotating two hours on and two hours off watch. During a watch the three team members rotated every 15 minutes among positions at the port binocular, the starboard binocular and the recorder station.

The observer at the port binocular was responsible for surveying the area between 0 and 90 degrees left; the observer at the starboard binocular for the area between 0 and 90 degrees right.

Watch was maintained during daylight hours (approximately 0600 to 1800) during all non-rain weather conditions.

On sighting a school of marine mammals certain information describing the sighting was recorded (e.g. time and position of the vessel, values of environmental parameters at the time of sighting, sighting cue and bearing and distance to the school). The bearing from the vessel to the sighted school was recorded by both the recorder as read by the observer from the azimuth ring on the binocular mount and by a computer (the Computer Assisted Sighting Technique (CAST) system) from a bearing encoder housed in the mount. Distance to the sighted school was recorded by the recorder as a reticle distance read from a reticle mounted in the binocular eyepiece.

Once a dolphin school had been sighted and tracked for approximately five minutes the Jordan diverted from the survey track line and approached the school whereupon estimates of school size and species composition were made.

2

Objective 2

Sighting methodology investigations included testing the CAST system and gathering information on the effects of watch length on results of sighting.

The CAST system, recently developed to more precisely measure bearing to a sighted school, was tested. CAST records the bearing to a sighting as read by an encoder in the binocular mounts. CAST converts bearing into a compass direction using information from the ship's gyro compass and corrects this direction for vessel pitch and roll using information from a pitch and roll sensor.

CAST keeps extensive tape records of binocular bearing by binocular position, date and time and, in addition, records the identities of personnel at the three watch stations.

The CAST system was initialized at the start of each observation day. Changes in the identies of watch personnel as well as any changes in ship speed or basic survey track heading were entered in the system through a terminal. At the end of each observation day the day's data were tested for completeness using CAST software then transferred to a permanent file, labeled to the particular date, on a data cartridge tape.

Gathering data on the effect of watch length, begun on previous marine mammal cruises, continued on leg 1. Preliminary analysis of previously gathered data suggested that a two-hours- on, two-hours-off rotation of teams was optimum. To confirm this finding watch lengths were varied among one, two and three hours. For one and two hour lengths observers rotated among watch stations (port binocular, starboard binocular and recorder) every 15 minutes. For the three hour watch length observers rotated every 30 minutes.

Objective 3

The reaction of dolphin schools to the approach of the Jordan was investigated by observing schools' reactions from a helicopter operated from the Surveyor. Successive positions of a school on the trackline were recorded from the time the school was sighted by the helicopter until it either passed by the Jordan or diverged to one side of the trackline. Successive school positions were estimated as successive radar positions of the helicopter as it passed over the school.

RESULTS:

Objective 1

Preliminary calculations indicate that 343 schools of marine mammals, containing an estimated 13,011 animals, were sighted. Of total schools sighted, 50% were seen on Leg 1, 16% on Leg 2 and 34 % on Leg 3. Seventy-two percent of all schools sighted (246 schools, estimated 12,739 animals) contained dolphin (Table 1). An additional 24% (82 schools, 265 animals) were of whales and 1% (3 schools, 3 animals) were of pinnipeds (Tables 2 and 3). Of the total, 3% of schools sighted were of undetermined identity.

Objective 2

The CAST system is a continuing developmental project and ,as such, was not expected to operate flawlessly throughout the entire cruise. Indeed, difficulties with system software immediately prior to the start of the cruise delayed the Jordan's departure for two days.

Anticipating possible difficulties with CAST and anticipating that these difficulties were most likely to occur on the middle leg of the cruise an electronics technician boarded the Jordan for leg 2 to maintain the system as necessary. As expected, there were few problems on leg 1; those that did occur were resolved by the Cruise Leader and the Jordan's radio operator. No days of CAST operation were lost on Leg 1.

Problems related to contamination of CAST hardware exposed to the weather and those related to vibration developed on Leg 2. The principal hardware problem involved deterioration of electronic parts and cables exposed to the weather. Approximately 1 day's use of CAST was lost while the electronics technician rebuilt affected components and replaced affected cables. There were two CAST system crashes on Leg 2, the result, apparently, of connectors between various hardware components working loose. Repairs were made by the electronics technician and minimum CAST time was lost.

No identifiable CAST hardware problems developed on leg 3. However toward the end of the leg an unidentified problem, attributable to either hardware or software, developed. The CAST operating system failed on 9 April.

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After several attempts the system was restarted only to fail again a short time later. This sequence of events was repeated four times on 9 and 10 April after which it became obvious to both the Cruise Leader and the *Jordan's* radio operator that no amount of connector wiggling and system restarting would cure the problem. The use of CAST was thereby lost for the final two observation days of the cruise.

Difficulties with the computer terminal developed on leg 2. After attempting to service this equipment the electronics technician concluded that the device could not be repaired on board. A replacement terminal was shipped to the *Jordan* at Papeete. Difficulties with the terminal resulted in only minimum lost CAST time.

Of the 22 observation days on leg 1, eight utilized the one-hour-on, one-hour off rotation schedule. Eight days utilized the two-hour and six days the three-hour schedules.

Objective 3

Results are summarized in the Cruise Report of the 1 March - 16 April 1983 cruise of the *Surveyor*.

ADDITIONAL OPERATIONS:

In cooperations with NOAA's Atlantic Oceanographic and Meteorologic Laboratories (AOML) and the University of California's Scripps Institution of Oceanography (SIO) and in support of future marine mammal/environment analyses a greater than usual number of environmental observations were made. This extra effort was aimed at gathering data on the anomalous warming of the eastern tropical Pacific Ocean (El Niño). AOML provided computer assisted XBT data recording equipment and additional XBT probes. SIO provided the services of a technician to make and record the extra observations. As weather permitted observations were made every six hours. Specific observations made include vertical temperature (XBT), surface temperature and salinity, surface chlorophyll content, wind speed and direction, swell height and direction and cloud type and degree of cover. Results include 307 observations of vertical and surface temperature, surface salinity and meteorological features and 336 discrete chlorophyll measurements.

Night squid jigging stations were held on an opportunistic basis to collect specimens for

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future studies of squid populations in the eastern Pacific Ocean. Gear included pole and line and commercial squid jigs. The Jordan's normal aft deck lights were used to attract squid. No special jigging gear or illumination were used.

Day pole and line and troll fishing for pelagic species was infrequently conducted. Gear included pole and line and troll gear. No special gear (e.g. outriggers, gurdies) were used.

Six squid stations were held. Approximately 34 jig hours of effort were expended and 67 squid caught. Five fishing stops were made during which 16 hook hours of effort were expended. Catches included nine mackerel, 28 dolphin fish and four yellowfin and seven skipjack tuna. Specimens of all squid species taken in each catch were frozen for future analysis. Samples of fish in each catch were measured and weighed and unusual specimens frozen for future analysis.

SCIENTIFIC PERSONNEL:

Dr. Wes Parks, SWFC, Chief Scientist, Cruise Leader legs 2 and 3.
Dr. Jay Barlow, SWFC, Cruise Leader, leg 1.

The following persons participated on legs 1, 2 and 3.

James Cotton, SWFC.
Jack Doxey, SBFC.
Michael Graybill, SWFC.
Michael Henry, SWFC.
Michael Marsh, SIO.
Robert Pitman, SWFC.
Gregory Yee, SWFC.

The following persons, of the SWFC, handled shoreside details as necessary.

Lloyd Farrar.
Dr. Rennie Holt.
Dr. Steve Reilly.
Dr. Gary Sakagawa.

DISPOSITION OF DATA:

7 notebooks of original marine mammal watch records (Objective 1) W. Parks. Delivered to R. Ralston for entry onto data base. Originals stored with Ralston.

5 binders of labeled slides in plastic sheets confirming identity of mammals sighted.

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Slides labeled to sighting and photographer. (Objective 1) W. Parks. Stored with Ralston.

7 data cartridges containing data recorded by CASI (Objective 1). R. Holt.

Environmental observations data (additional operations). S. Reilly.
- XBT data cartridges.
- Meteorological observations notebook.
- Chlorophyll and salinity station data sheets.
- Thermosalinograph plots.
- Chlorophyll plots.
- Salinity samples.

1 carton of frozen fish/squid samples (additional operations). A. Dizon.

Prepared by: ______________________ Wesley Parks, Chief Scientist — 6 May 1983 Date

Approved by: ______________________ Izadore Barrett, Director, F/SWC — 5/6/83 Date

cc: Barrett, F/SWC
Sakagawa, F/SWC1
Hawes, F/SWC1
Farrar, C7
Hitz, CPM12
David Starr Jordan, CPM 443

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Appendix 2X. Cruise report for SWFSC Cruise 0843. (Continued)

Table 1. Preliminary summary statistics of sightings of marine mammal schools containing dolphins (order cetacea, suborder odontoceti, family delphinidae), Cruise DS83-01.

School type	Species	Leg 1 Number of schools	Leg 1 Number of animals	Leg 2 Number of schools	Leg 2 Number of animals	Leg 3 Number of schools	Leg 3 Number of animals	Total Number of schools	Total Number of animals
Pure dolphin	Delphinus delphis	20	2285	2	951	8	1111	30	4347
	Globicephala macrorhynchus	5	56	1	1	0	0	6	57
	Grampus griseus	14	118	3	16	4	19	21	153
	Lagenorhynchus obliquidens	2	18	0	0	3	20	5	38
	Orcinus orca	0	0	0	0	1	2	1	2
	Peponocephala electra	0	0	0	0	2	97	2	97
	Pseudorca crassidens	0	0	1	1	0	0	1	1
	Stenella attenuata	9	635	6	418	7	353	22	1406
	S. coeruleoalba	16	1056	3	154	4	169	23	1379
	S. longirostris	3	216	0	0	7	365	10	581
	Steno bredanensis	4	20	0	0	2	11	6	31
	Tursiops truncatus	8	82	3	22	3	58	14	162
	Unidentified delphinid	34	240	17	145	18	278	69	663
	Total	115	4726	36	1708	59	2483	210	8917
Mixed dolphin	Delphinus delphis + Stenella coeruleoalba	1	139	0	0	0	0	1	139

Appendix 2X. Cruise report for SWFSC Cruise 0843. (Continued)

Table 1. Continued

School type	Species	Leg 1 Number of schools	Leg 1 Number of animals	Leg 2 Number of schools	Leg 2 Number of animals	Leg 3 Number of schools	Leg 3 Number of animals	Total Number of schools	Total Number of animals
	D. delphis + G. griseus	2	225	0	0	0	0	2	225
	D. delphis + Unidentified delphinid	1	10	0	0	0	0	1	10
	D. delphis + L. obliquidens + S. attenuata	1	393	0	0	0	0	1	393
	G. macrorhynchus + T. truncatus	5	118	1	12	0	0	6	130
	G. griseus + T. truncatus	1	93	0	0	0	0	1	93
	G. griseus + Unidentified Delphinid	1	10	0	0	0	0	1	10
	S. attenuata + S. longirostris	6	573	0	0	13	2039	19	2612
	S. attenuata + T. truncatus	0	0	0	0	1	40	1	40
	S. coeruleoalba + T. truncatus	1	102	0	0	0	0	1	102
	S. bredanensis + T. truncatus	0	0	0	0	1	11	1	11
	Total	19	1663	1	12	15	2090	35	3765
Total	Dolphin	134	6389	37	1720	74	4573	245	12682
Mixed dolphin and other marine mammals									
	D. delphis + Megaptera novaeangliae	0	0	0	0	1	19	1	19
	T. truncatus + M. novaeangliae	0	0	0	0	1	22	1	22
	T. truncatus + Physeter macrocephalus	1	16	0	0	0	0	1	16
	Total	1	16	0	0	2	41	3	57
Total all schools with at least some dolphin		135	6405	37	1720	76	4614	248	12739

Appendix 2X. Cruise report for SWFSC Cruise 0843. (Continued)

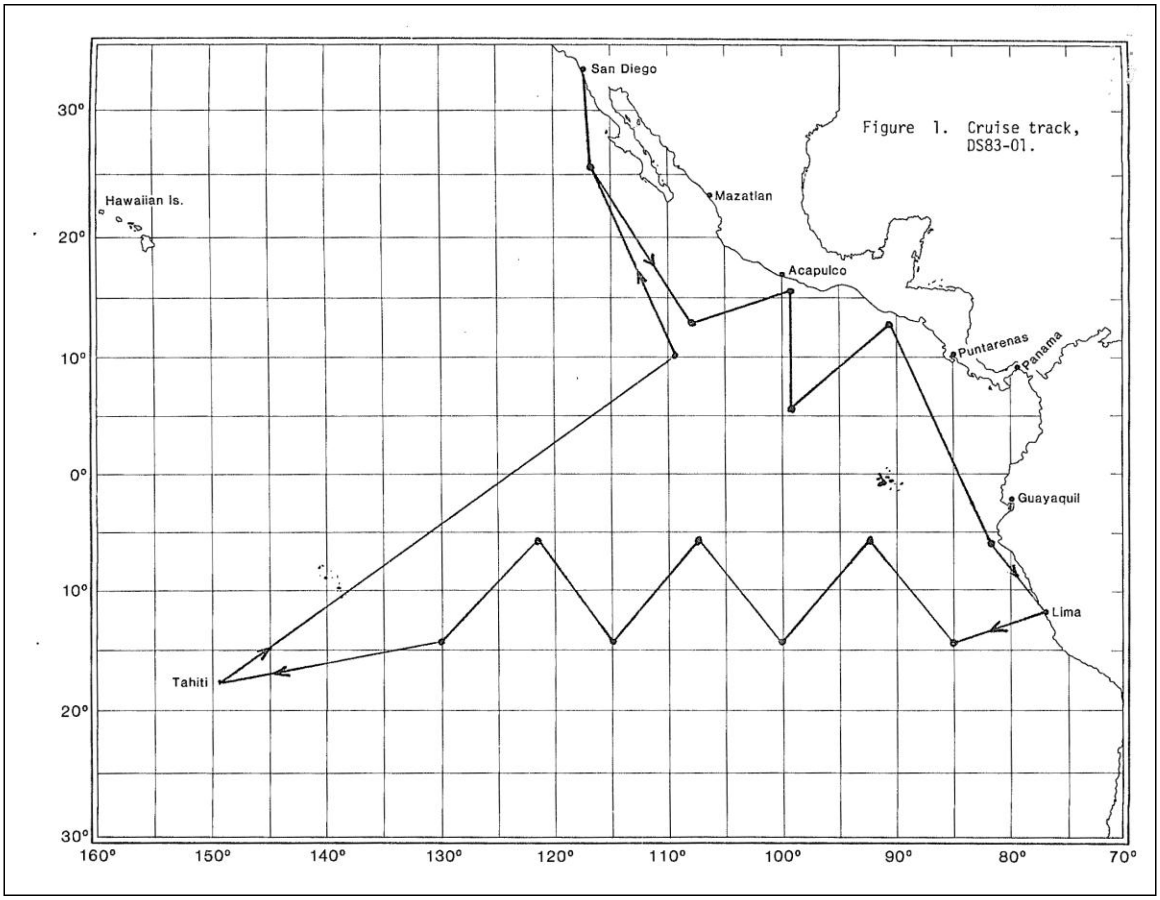
Table 2. Preliminary summary statistics of sightings of marine mammal schools containing cetacea other than Delphinids, Cruise DS83-01.

Sub-order	Family	Species	Leg 1 Number of schools	Leg 1 Number of animals	Leg 2 Number of schools	Leg 2 Number of animals	Leg 3 Number of schools	Leg 3 Number of animals	Total Number of schools	Total Number of animals
Mysticeti	Balaenopteridae	Balaenoptera edeni	0	0	1	2	2	2	3	4
		B. musculus	0	0	0	0	1	12	1	12
		B. species	0	0	2	3	0	0	2	3
		Megaptera novaeangliae	0	0	0	0	1	2	1	2
		Unidentified	0	0	1	1	2	3	3	4
		Mixed B. musculus + M. novaeangliae	0	0	0	0	1	5	1	5
		Total	0	0	4	6	7	24	11	30
	Eschrichtidae	Eschrichtius robustus	4	32	0	0	1	1	5	33
		Total	4	32	4	6	8	25	16	63
Odontocete	Physeteridae	Kogia simus	0	0	0	0	7	9	7	9
		K. species	0	0	0	0	3	5	3	5
		Physeter macrocephalus	3	17	7	33	4	14	14	64
		Total	3	17	7	33	14	28	24	78
Unidentified whale			28	34	4	5	9	13	41	52
Mixed B. musculus + Unidentified W			0	0	0	0	1	12	1	12
Total			35	83	15	44	32	78	82	205

Table 3. Preliminary summary statistics of sightings of marine mammal schools other than those in the order Cetacea, Cruise DS83-01. All schools were in the order Pinnipedea.

Species	Leg 1 Number of schools	Leg 1 Number of animals	Leg 2 Number of schools	Leg 2 Number of animals	Leg 3 Number of schools	Leg 3 Number of animals	Total Number of schools	Total Number of animals
Mirounga angustirostris	0	0	0	0	1	1	1	1
Zalophus californianus	0	0	0	0	2	2	2	2
Total	0	0	0	0	3	3	3	3

Appendix 2X. Cruise report for SWFSC Cruise 0843. (Continued)



Appendix 2Y. Cruise report for SWFSC Cruise 0852.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Southwest Fisheries Center
National Marine Fisheries Service
La Jolla, California 92038

CRUISE REPORT Cr# 852

VESSEL:

NOAA Ship Surveyor Cruise RP-12-SU-83.

Porpoise Avoidance Experiment (PAX).

ITINERARY:

The ship departed Seattle on March 3, 1983 after fueling at Pier 91 and proceeded south. The ship hove to off La Jolla, California, on the 7th of March and onloaded the scientific party and their equipment using the helicopter. Operations began the second day out of La Jolla as the ship proceeded south to the vicinity of Clipperton Island. Operations were conducted to the east of Clipperton and then to the north toward Manzanillo. Work was suspended within 200 miles of the coast of Mexico and the ship made port in Manzanillo on the 18th of March. Inability to obtain fuel on schedule and a pipe failure in the engine room forced a delay in departure from Manzanillo to the 25th of March. A rendezvous with the NOAA ship David Starr Jordan was accomplished on March 26 southwest of Clipperton Island. Operations proceeded to the north of Clipperton until April 7, when work was suspended and both ships returned to San Diego.

March 1	Depart Pacific Marine Center
March 3	Depart Seattle
March 7	Arrive La Jolla, load personnel and equipment
March 18	Arrive Manzanillo, Mexico
March 25	Depart Manzanillo, Mexico
March 26	Rendezvous with NOAA ship David Starr Jordan
April 7	Depart working grounds
April 11	Arrive San Diego

OBJECTIVES:

The Marine Mammal Protection Act of 1972 prohibits the harvest of marine mammals and specifies that the federal government may issue permits for their take only under special circumstances. One such circumstance involves the incidental kill of dolphins associated with the yellowfin tuna fishery in the eastern tropical Pacific Ocean. Before issuing the permits, the government must first certify the viability of the affected dolphin populations. To meet this requirement, the Southwest Fisheries Center defines interbreeding stocks and monitors their population demography, reproductive output, longevity and abundance.

Most of the vital statistics are derived from specimens obtained from the tuna fishery. However, to estimate abundance, surveys are conducted using ships and aircraft independently of the fishery. The surveys, using line transect methods, have yielded estimates of the density of dolphins in the eastern tropical Pacific Ocean. A critical assumption in the application of the method is that the animals do not move, in reaction to the observer, prior to their detection. In practice, a detection function, which is relatively insensitive to movement, is used to describe the probability of observing a school of dolphins given its position relative to the observer's transect. The present field experiment was designed:

1. To test the assumption that the animals do not react prior to shipboard detection and, in so doing,

2. To collect the kind of data that would facilitate a correction to density estimates, if necessary.

A similar experiment was conducted using the NOAA Ship *Surveyor* and a ship supported helicopter in 1977 (Au and Perryman, 1982)[1]. The sample size was small (8 schools) and their results were ambiguous and difficult to interpret in the context of line transect theory. However, they acquired a substantial amount of behavioral information and determined that dolphins do not react to a helicopter at an altitude of 1200 feet. In preparing for this cruise, it was recognized that a unique opportunity existed to elaborate on Au and Perryman's observations. Thus, a third objective was to:

3. Obtain aerial photographs and video recordings of dolphin schools.

These recordings document species identifications, school structure, behavior, and school size. Photographs were also taken of other marine mammals and extensive field notes were taken during all observations. In particular, our attention was drawn to the apparent interaction between bait, tuna, birds and dolphins.

METHODS

The experiment was designed to observe the efficiency of shipboard survey operations by using a helicopter to track dolphin schools before, during and after shipboard detection. Alternately, a set of behavioral observations could have been obtained which would have contributed to a general description of the reaction of dolphin schools to ships in the eastern tropical Pacific Ocean. Two considerations dictated an operations research rather than a behavioral experiment:

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[1] Au, D. and W. Perryman 1982. Movement and speed of dolphin schools responding to an approaching ship. U.S. Fish Bull. 80(2): 371-379. (Reprints on file at the Southwest Fisheries Center, La Jolla, CA)

1) It was not reasonable to assume that movement of a dolphin school and the probability of detecting it are unrelated (i.e., it may be easier to see a school in full flight than one at rest). Therefore, associated data on movement and shipboard detection were collected for each school.

2) It was necessary to separate random movement from directed movement toward or away from the survey vessel. To do so unambiguously, the ship could not be turned toward a school, but rather had to continue searching along a predetermined transect.

From the experience gained on the 1982 Jordan survey, we expected 80% of the sighting cues to be within 3 n. mi. of the transect line and less than 5 n. mi. ahead of the vessel. Furthermore, the Au and Perryman observations on eight schools suggested that dolphins may react to a ship 6 n. mi. away. With these considerations and prior experience in mind, the following field procedure was employed.

The ship (either Surveyor or later the Jordan) proceeded in a survey mode along a predetermined transect. The helicopter searched 8 to 12 n. mi. ahead of the ship and 2 n. mi. to either side of the transect line, at right angles to the direction of the ship's travel. When a school was sighted by the helicopter, shipboard radar observers were notified and tracking began. Schools were tracked for typically an hour's time until one of three events occurred: 1) the school passed abeam of the ship; 2) the school passed beyond the visual range of shipboard observers; or 3) we lost sight of the school and had to terminate the track prematurely.

During a track, the helicopter was positioned over the school at a minimum altitude of 1200 feet; the radar range and bearing to the helicopter were determined from the approaching survey vessel every 4 minutes. A transponder, mounted on the aircraft, facilitated accurate radar measurements. In addition, OMEGA navigation positions were recorded from dual systems aboard the helicopter and the ship. As the track progressed, field notes were taken on visual observations of school behavior and associated birds and fish; where sea state permitted, 35 mm photographs were obtained from the tracking altitude. This altitude appeared to be sufficient so as not to elicit a response from the animals. It also placed the helicopter above the shipboard observers' vertical field of vision and therefore did not prematurely cue them on a school. Two oil drums were released and tracked at the beginning of the cruise to evaluate the expected precision of the procedure; the results were considered adequate for our purpose.

Shipboard observers were stationed on the flying bridge in a standard survey configuration, using 25x 150 mm mounted binoculars to search forward of the ship (Holt and Powers, 1982)[2]. Records were maintained on search effort

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[2]Holt, R.S. and J.E. Powers. 1982. Abundance estimation of dolphin stocks involved in the eastern tropical Pacific yellowfin tuna fishery determined from aerial an ship surveys to 1979. NOAA Technical Memorandum NMFS-SWFC-23: 95p. (Reprints on file at the Southwest Fisheries Center, La Jolla, CA.)

sighting cues. Shipboard observers were not aware of a track in progress until its termination.

At the finish of a track, the helicopter descended to a lower altitude for additional photography and to estimate school size and species composition. The ship approached a limited number of schools to enable close-range estimates of school size and species composition. A few schools were also photographed at 900 feet altitude, using vertically mounted 5" and 2 1/4" format cameras. After school size and species composition were determined, normal survey operation resumed, with the helicopter searching ahead of the vessel and the shipboard observers actively scanning and recording search effort.

The sample design was opportunistic and only specifically designed to compare between the two ships. Should a sufficient variety of conditions be encountered, it was intended to stratify additionally by sea state, species, distance from land and school size. Data were collected with the objective of describing:

1) Reaction distance and the nature of subsequent behavior;

2) The proportions of the apparent detection function caused by visibility effects and by movement effects; and

3) The natural linear density of schools unaffected by the limitations and presence of the observer.

If the reaction distance was consistently less than the sighting distance, then the latter two descriptions would be trivial; i.e., the encounter rate along the transect line is the undisturbed density.

Field notes and photographic records were also obtained of marine mammals other than those implicated in the yellowfin tuna fishery. The Surveyor and her helicopter provided an unique observation platform; it was difficult not to appreciate this fact. We obtained video recordings of migrating pods of sperm whales; we photographed the bird colonies on Clipperton Island; we determined the speed of migrating flocks of red footed and masked boobies; we photographed several large whale sharks; and we obtained a variety of records on the natural history of the region. A more complete species list is presented below.

RESULTS

Avoidance

Tracks were started on a total of 26 dolphin schools, 5 in front of the Surveyor, 21 in front of the Jordan; a very abbreviated summary of the observations is listed in Table 1. Seven of the tracks were terminated prematurely and of the remaining 19, 6 schools passed undetected by shipboard observers. These 6 schools did not appear to adjust their direction or speed of movement in reaction to the survey vessel.

Of the remaining 13 schools, one altered its direction of movement in reaction to the approaching ship, prior to the detection of a sighting cue by the shipboard observers. Twelve schools were detected (either directly or by sighting cue) before they reacted to the passage of the ship, if they reacted at all. The preliminary conclusion, pending more detailed analyses of absolute school movement, is that dolphin schools may rarely be expected to adjust their distribution prior to being detected by shipboard survey observers. One of the 12 schools was composed of Steno bredanensis (rough-toothed dolphin), which is not directly impacted by the fishery and is not a target of abundance surveys. Thus, from the results of this experiment, it is expected that 8% (1/12) of the schools encountered on a survey will have moved prior to detection.

The school that did move away from the transect line before shipboard detection (#8) would have been sighted at 0.1 n. mi. off the transect line if it had not altered the direction and speed of its movement. It was detected at 1.0 n. mi. off the transect line. If the sample size was larger, such information could be used to dissect the detection function (which is proportional to the frequency distribution of the observed perpendicular sighting distances) into that component which is the result of decreasing visibility with distance from the transect line, and into that component which is the result of dolphin schools adjusting their natural spatial disposition. There are, however, other factors (such as glare and sea state) which are seldom constant long enough to allow for accumulation of a reasonably precise frequency distribution, such that the effects due to school movement would not be overwhelmed by the expected variability. The sample size was also insufficient to compare between ships, sea state, species, distance from land and school size.

The results of this experiment can be used to suggest that 1) dolphin schools rarely react to the approach of a survey vessel prior to their detection by shipboard observers; and 2) the expected rarity of the event implies that a considerable amount of data would be required to quantify its effect.

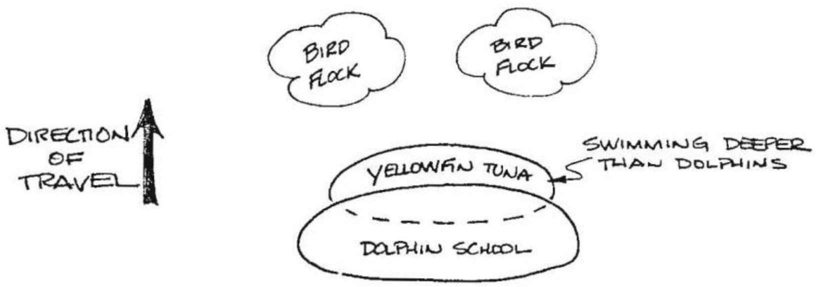
Estimates of School Size and Species Composition

A limited number of schools were approached at close range by the vessel so that shipboard observers could make estimates of school size and species composition using the same techniques that were used on abundance surveys. Estimates of school size and species composition were made independently by three to six shipboard observers and averaged, giving each an equal weight. These estimates compared favorably with estimates made by a single aerial observer stationed in the helicopter (Table 2). Shipboard estimates of school size ranged from 65% to 134% of the aerial estimates and averaged 101%; shipboard and aerial observers agreed on the species composition for all six schools compared, although there was some variation in the proportion assigned to each species. All observers agreed that they could more confidently estimate school size from the air than from a vessel. The helicopter provides a vantage point from which the entire school can be observed over an extended period of time, making it easier to estimate that portion of the school which is submerged and not visible.

Fish, Birds and Dolphins

The association of yellowfin tuna and dolphins (primarily of the genus Stenella) has long been exploited by the tuna fleet operating in the eastern tropical Pacific, but poorly understood. The association is likely prey-oriented, although this has never been established with any certainty nor have other possible motivations been eliminated (Stuntz, 1981)[3].

Of the 26 dolphin schools tracked with the helicopter, 14 were associated with birds; 8 of these were also associated with tuna. In every instance, the tuna were observed in the lead, out in front of the dolphins. Bird activity was consistently ahead of the main aggregation. When Stenella attenuata and S. longirostris occurred together, the two species maintained distinct subgroups; usually S. attenuata formed the core of a school with small groups of S. longirostris at the periphery. In all cases, there was a measurable net movement of the aggregation concurrent with feeding activity. Although the disposition of individuals was very fluid, the following general pattern was discernible:



Based on our field notes we offer the following hypothesis: the association of yellowfin tuna and dolphins in the eastern tropical Pacific is based on exploitation of a common prey. The tuna dive deeper than the dolphins and chase prey up into the surface layer where both birds and dolphins take advantage of the increased food availability. The dolphins thus capitalize on the feeding activity of the tuna. The tuna may actively maintain the association by responding to a general tendency among pelagic schooling fish to swim with similar sized objects moving at similar speeds.

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[3] Stuntz, W.E. 1981. The tuna-dolphin bond: A discussion of current hypotheses. SWFC Admin. Rep. LJ-81-19: 9p. (Reprints on file at the Southwest Fisheries Center, La Jolla, CA)

Data Summary

Observations of the following species were recorded in one or more of several forms (field notes, photographs, video tape):

Cetaceans;	Stenella attenuata	(Spotted dolphin)
	S. longirostris	(Spinner dolphin)
	S. coeruleoalba	(Striped or streaker dolphin)
	Grampus griseus	(Risso's dolphin)
	Tursiops truncatus	(Bottlenose dolphin)
	Steno bredanensis	(Rough-toothed dolphin)
	Globicephala macrorhynchus	(Pilot whale)
	Lagenorhynchus obliquidens	(Pacific white-sided dolphin)
	Phocoenoides dalli	(Dall's porpoise)
	Mesoplodon spp.	(Beaked whales)
	Ziphius cavirostris	(Curier's beaked whale)
	Kogia spp.	(Pygmy and dwarf sperm whales)
	Physeter macrocephalus	(Sperm whale)
	Baleanoptera edeni	(Bryde's whale)
Elasmobrandus;	Rhincodon typus	(Whale shark)
	Sphyrna spp.	(Hammerhead sharks)
	Manta hamiltoni	(Manta ray)
Bony fish;	Thunnus albacares	(Yellowfin tuna)
	Cypselurus spp.	(Flying fish)
Birds;	Sula sula	(Red footed booby)
	S. leucogaster	(Brown booby)
	S. dactylatra	(Masked booby)
	Phaethon ribricauda	(Red-tailed tropic bird)
	P. aethereus	(Red-billed tropic bird)
	Stercorarius pomarinus	(Pomarine jaeger)
	Puffinis pacificus	(Wedgetailed shearwater)
	P. nativitatis	(Christmas shearwater)
	P. griseus	(Sooty shearwater)
	Sterna fuscata	(Sooty tern)
	Sterna albifrons	(Least tern)
	Gygis alba	(White tern)
	Diomedea nigripes	(Blackfooted albatross)
	D. immutabilis	(Layson albatross)

We were alloted 45 days of ship time, of which 18 days were in transit, 7 days were in port and 20 days were spent collecting data with the helicopter. We logged 110 hours of helicopter search effort which yielded 26 dolphin school tracks (partial and complete) and 57 other sightings. Observers aboard the Surveyor recorded 48 hours of search effort and 53 sightings of marine mammals. We exposed 64 rolls of 35 mm film (color and black and white), 105 feet of 2 1/4" film, and 117 feet of 5" film; we recorded 4 hours of video tape.

OTHER ACTIVITIES

A geographically extensive warming of surface waters became evident in the eastern Pacific Ocean in 1982. Similar anomolous events, referred to El Nino, have occurred several times during this century. Effects of the present El Nino have been reported from Chile and Peru in the southern hemisphere to Mexico and California, U.S.A. in the northern hemisphere; the phenomena continue to persist into 1983. We obtained a limited suite of hydrographic measurements, while in the eastern tropical Pacific, to contribute to the documentation of this event. Oceanographic measurements included 53 profiles of temperature and salinity to 1000 m depth (CTD's), approximately 170 expendable bathythermographs (XBT's), and approximately 800 hours of thermosalinograph record (Figures 1, 2 and 3). Preliminary scanning of the data indicates that the surface layer temperatures were not warmer than usual; however, the thickness of the layer (as indicated by the thermocline position) was approximately 50% greater than normal years (60-100 m versus <50 m).

The Sea Beam acoustic system, used to map bottom topography, was operated in transit to and from the working grounds. It was not operated in the eastern tropical Pacific because of the possible effect on marine mammals. Ship's personnel also participated in the SEAS/GOES project by transmitting meteorological and XBT observations via the GOES satellite; copies of these records were forwarded to the National Weather Service. Copies of all CTD and XBT records were forwarded to the Atlantic Meterological and Oceanographic Laboratory who expressed an interest in obtaining data on the El Nino effect.

SCIENTIFIC PERSONNEL

Dr. Roger Hewitt, Southwest Fisheries Center, Chief Scientist
Gary Friedrichsen, Southwest Fisheries Center, Field Biologist
Al Jackson, Southwest Fisheries Center, Data Manager/Porpoise Observer
William Irwin, Southwest Region, Video Technician/Porpoise Observer
Michael Noel, Southwest Region, Supply/Porpoise Observer

BREAKDOWNS

Local holidays prevented the ship from obtaining fuel on schedule in Manzanillo and caused a departure delay of one day. Departure was delayed an additional two days when a fuel transfer line ruptured in the engine room. The primary radar on the *Jordan* failed and could not be repaired; fortunately, we were able to track the helicopter with the *Jordan*'s second radar. We experienced numerous problems with the video camera and recorder throughout the trip; as a result, several opportunities to record events were lost. We recommend that future expeditions be equipped with commercial grade equipment; the home video system we had, while of good quality, was not sturdy enough to withstand daily use on board ship and in the helicopter.

SHIP SUPPORT

The competence and enthusiasm of the *Surveyor*'s officers and crew contributed greatly to the success of the cruise. They willingly accommodated all of our requests and through their suggestions improved our operations. The flight crew was also outstanding; they were cooperative and genuinely interested in the experiment. We did not suffer any loss of helicopter time primarily because of the mechanic's diligence in maintenance and repair. We are convinced that our chances for success in the field are maximized by using government-operated research platforms.

Abundance surveys of dolphin stocks may be more efficiently conducted using a ship/helicopter combination. The sample area could be greatly augmented by using both the ship and the helicopter to search for dolphins. In addition, time consuming breaks in vessel search effort could be avoided by using the helicopter to determine species composition and school size.

Prepared by: Roger Hewitt
Roger Hewitt, Chief Scientist

5/24/83
Date

Approved by: Izadore Barrett
Izadore Barrett, Director, SWFC

6/1/83
Date

Attachments: 2 tables
3 figures

Appendix 2Y. Cruise report for SWFSC Cruise 0852. (Continued)

Table 1. Abbreviated summary of dolphin school tracking data.

	School Number	Beaufort Sea State	Species Composition	Number of Individuals	Closest point of approach (n. mi.)	Reaction (Distance (n. mi.)	Radial Sighting Distance (n. mi.)	Perpendicular Sighting Distance (n. mi.)
Surveyor	1	1	Steno bredanensis 100%	9	1.3	F[1]	2.5	1.7
	2	1	Stenella attenuata 50% S. longirostris 50%	175	7.0	F[1]	F[2]	
	3	3	S. attenuata 100%	53	2.5	F[1]	F[2]	
	4	5	Unidentified dolphins 100%	100	2.0	F[1]	2.0	1.0
	5	5	Unidentified dolphins 100%	15	F[3]			
Jordan	6	4	Unidentified dolphins 100%	22	F[3]			
	7	4	Unidentified dolphins 100%	35	F[3]			
	8	4	S. attenuata 80% S. longirostris 20%	300	1.5	2.5	1.5	0.6
	9	4	Unidentified dolphins 100%	25	F[3]			
	10	4	S. attenuata 15% S. longirostris 85%	144	0.5	0.5	6.0	0.3
	11	4	S. attenuata 100%	25	5.0	F[1]	6.8	2.7
	12	4	S. attenuata 15% S. longirostris 85%	65	7.0	F[1]	F[2]	
	13	4	S. attenuata 65% S. longirostris 35%	175	1.3	2.0	6.8	0.5
	14	4	S. attenuata 90% S. longirostris 10%	50	2.5	F[1]	6.0	0.0
	15	4	Stenella spp. 100%	150	F[3]			
	16	4	S. attenuata 100%	35	1.2	1.5	6.0	0.3
	17	3	Unidentified dolphins 100%	40	F[3]			
	18	3	S. coeruleoalba 100%	160	F[3]			
	19	3	S. attenuata 100%	45	3.0	F[1]	F[2]	
	20	0	S. attenuata 15% S. longirostris 85%	260	1.7	F[1]	6.8	0.6
	21	2	S. attenuata 91% S. longirostris 9%	230	6.0	F[1]	F[2]	
	22	1	S. attenuata 50% S. longirostris 50%	180	2.0	2.0	6.8	2.3
	23	1	S. attenuata 50% S. longirostris 50%	155	1.5	F[1]	6.0	0.4
	24	1	S. coeruleoalba 100%	29	0.1	F[1]	1.5	0.5
	25	1	S. attenuata 40% S. longirostris 60%	410	2.0	F[1]	4.0	1.0
	26	1	S. attenuata 100%	85	3.0	F[1]	F[2]	

[1] School did not appear to react to the approach of the survey vessel.

[2] School passed undetected by shipboard observers.

[3] Track prematurely terminated.

Appendix 2Y. Cruise report for SWFSC Cruise 0852. (Continued)

Table 2. Comparison of aerial and shipboard estimates of school size and species composition.

	Helicopter Estimate		Vessel Estimate	
School Number	Number of Individuals	Species Proportions	Number of Individuals	Species Proportions
20	260	*S. attenuata* (0.15) *S. longirostris* (0.85)	248	*S. attenuata* (0.15) *S. longirostris* (0.85)
22	180	*S. attenuata* (0.50) *S. longirostris* (0.50)	241	*S. attenuata* (0.95) *S. longirostris* (0.05)
23	155	*S. attenuata* (0.50) *S. longirostris* (0.50)	139	*S. attenuata* (0.60) *S. longirostris* (0.40)
24	29	*S. coeruleoalba* (1.00)	36	*S. coeruleoalba* (1.00)
25	410	*S. attenuata* (0.40) *S. longirostris* (0.60)	393	*S. attenuata* (0.55) *S. longirostris* (0.45)
26	85	*S. attenuata* (1.00)	55	*S. attenuata* (1.00)

Appendix 2Y. Cruise report for SWFSC Cruise 0852. (Continued)

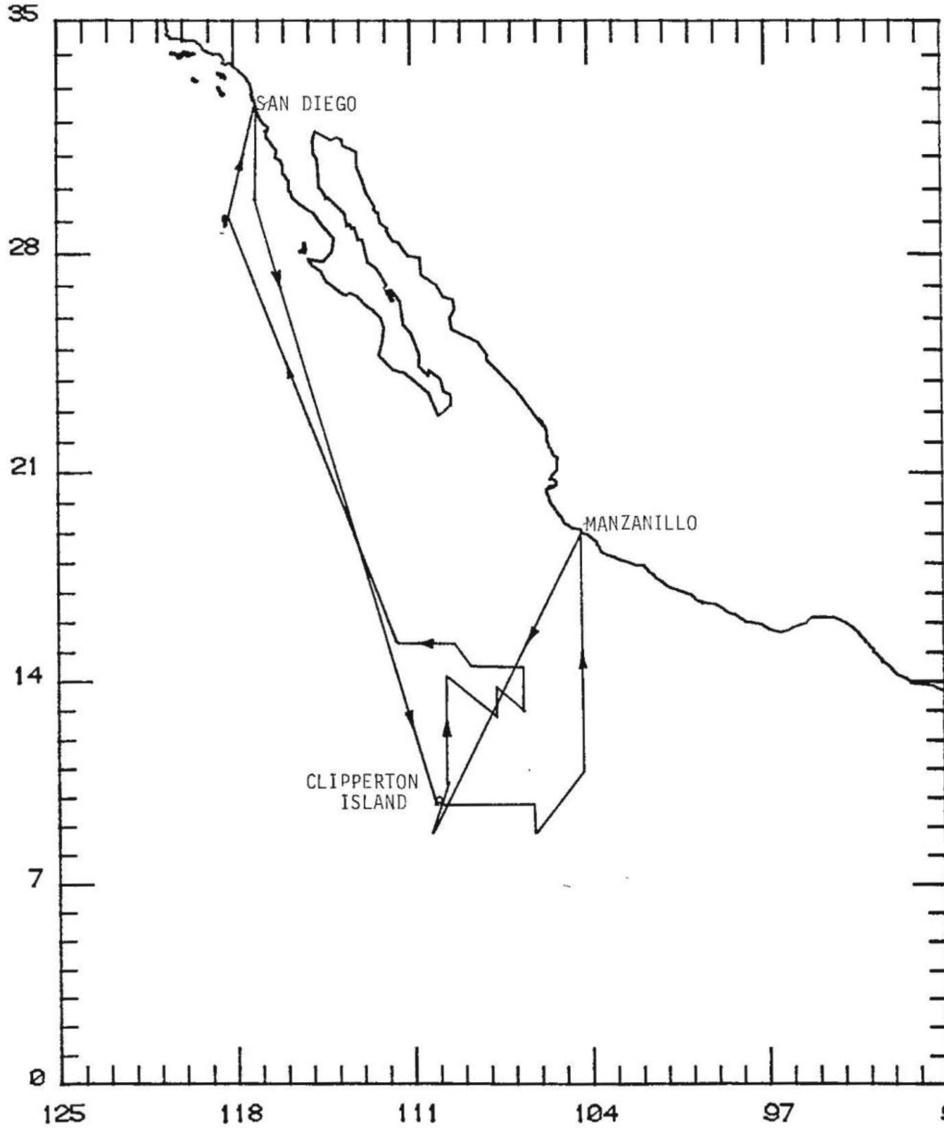

FIGURE 1. Cruise trackline.

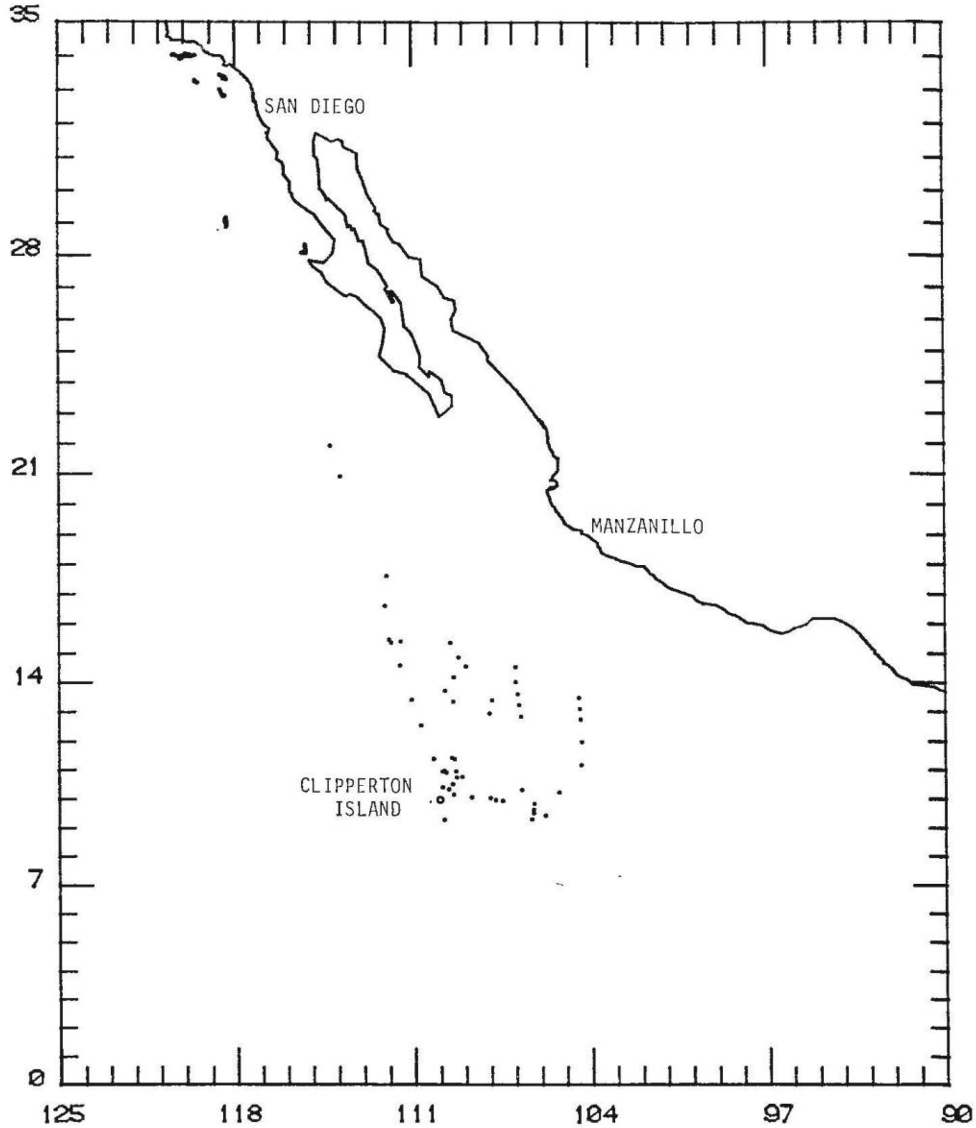

FIGURE 2. Salinity and temperature profiles (CTD's).

Appendix 2Y. Cruise report for SWFSC Cruise 0852. (Continued)

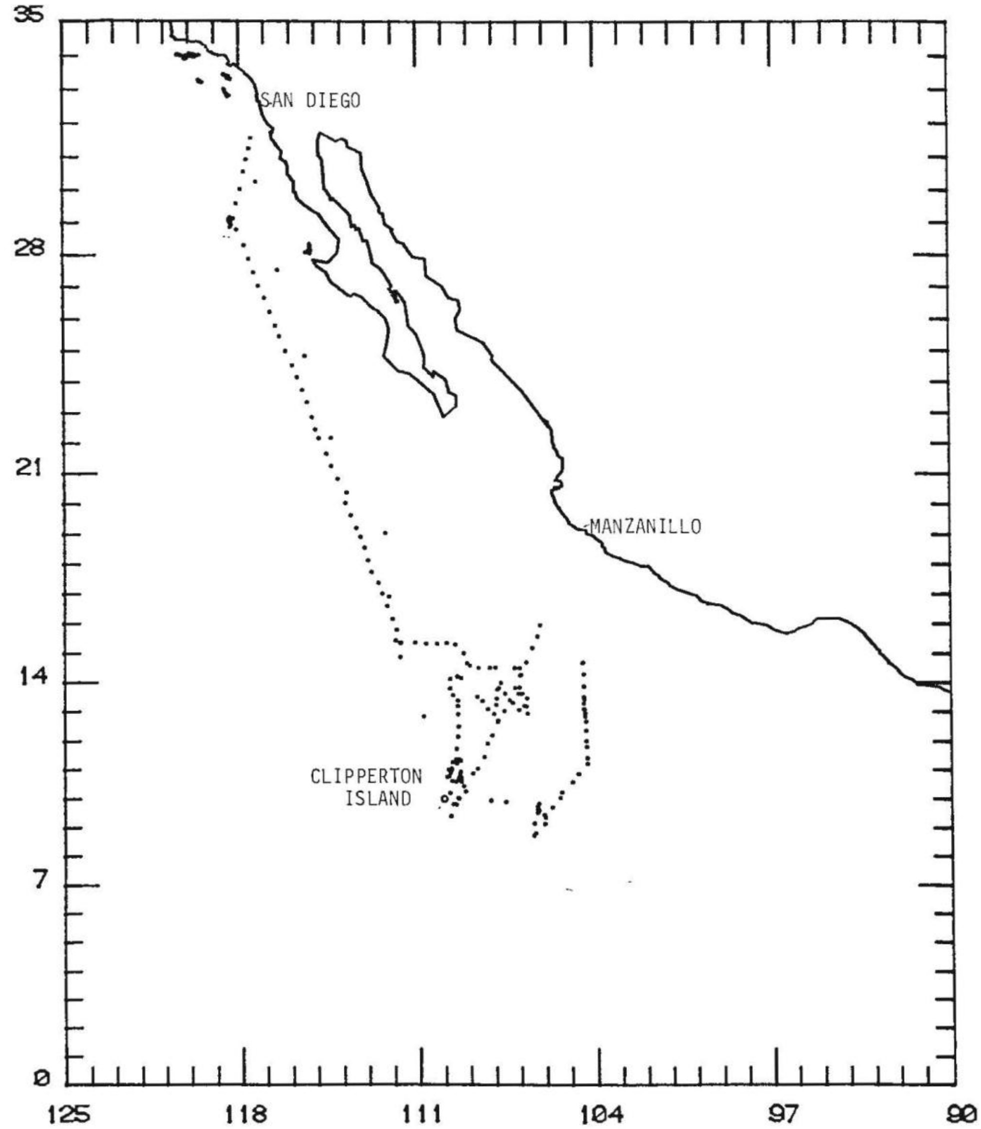

FIGURE 3. Expendable bathythermographs (XBT's).

Appendix 2Z. Cruise report for SWFSC Cruise 0874.

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Southwest Fisheries Center
National Marine Fisheries Service
La Jolla, California 92038

CRUISE REPORT

VESSEL: RV David Starr Jordan (DS 84-11).

CRUISE DATES: December 5-11, 1983

ITINERARY: Leg 1: Depart San Diego 0600, December 5, 1983
Arrive San Diego 1200, December 11, 1983

PURPOSE: To determine relative abundance of pilot whales in the Southern California Bight (SCB).

OBJECTIVES: (1). To determine density of pilot whales around Catalina Island.

(2). To determine the relative abundance of small cetaceans in the SCB.

(3). To determine relative abundance of sea lion prey species such as anchovy, squid, hake and rockfish.

(4). To investigate relationship between dolphin distributions and sea surface temperatures, depth of mixing layer, and depth of the thermocline.

(5). To collect specimen material from fish caught in trawl nets.

RESULTS: (1 & 2). No pilot whales were seen during the entire cruise. This is probably related to the lack of significant squid spawning aggregations around the islands in the Southern California Bight. In 7 days of surveys (roughly 70 hours), 69 sightings of cetaceans were made. The sightings (number of schools) were as follows:

DAY

Species	1	2	3	4	5	6	7	Total (%)
Pacific White Sided	4	2	1	6	-	4	2	19 (28)
Common	-	4	5	3	1	3	5	21 (30)
Bottlenose	-	1	-	1	-	1 1/2+	-	3 1/2 (5)
Dall's	-	1	-	1	-	2 1/2	-	4 1/2 (7)
Risso's	-	-	1	1	-	4 1/2	-	6 1/2 (10)
Gray	-	-	-	1	-	-	-	1 (1)
Sperm	-	1	-	-	-	-	-	1 (1)
Minke	-	-	-	-	-	1/2	-	1/2 (1)
Unknown	1	2	4	1	1	0	3	12 (17)
	5	11	11	14	2	16	10	69 (100)

* 1/2 denotes a mixed school

Size estimates were made for each school. In addition, estimates of radial distance off the track line and bearing were taken for each school sighted. This information will be used in a line transect estimate of school density. The sighting and efforts forms are currently being key punched and edited.

The most common species of cetacean sighted by percentage was the common dolphin (30% of all sightings). This species had the largest average school size as well as being the most common in number of individuals. Large concentrations of common dolphins were seen on the south side of Santa Rosa and Santa Cruz Islands. Roughly, 17% of all sightings were not identified to species.

Results of a survey for pilot whales conducted by a contractor from shore on Catalina Island supported the Jordan's survey results that no pilot whales were around Catalina Island at this time. In addition, no pilot whales were seen during aerial surveys, flown on December 11 and 14th, around Catalina Island.

(3). Twenty-two mid water trawl hauls were made in 6 nights. Each evening, hauls were made at a depth between 50 m and 200 m. Trawls were fished for 30 minutes at roughly 3 knots. The depth of the trawl was determined by searching for schools of fish on the EK-400. Although the average catch was 55 kg./haul, 67% of the total catch occurred in the first 3 hauls. Sixteen species occurred in the 22 hauls, as follows:

Appendix 2Z. Cruise report for SWFSC Cruise 0874. (Continued)

Genera	Occurrence	Genera	Occurrence
Engraulis	21	Cyclothone	1
Trachurus	8	Sebastes	2
Pleuroncoides	17	Porichthys	3
Loligo	4	Torpedo	1
Sardinops	1	Leuroglossus	2
Etrumeus	1	Unidentified squid	2
Scomber	1	Merluccius	3
Myctophid	9	Mola	3

Anchovies represented 87% of the total catch (1219 kg). All species were sampled to determine length-frequency distributions. Anchovies were generally between 110 and 120 mm.

(4). Twenty-three XBT's were launched, one at 0900, 1200, and 1500, and whenever cetaceans were sighted. Sea surface temperature (SST) varied between 17.8 ^{o} C and 14.6^{o}C. The average SST was 16.3^{o}C. A majority of the SST's were above 16^{o}C. The average depth of the mixing layer was 35.2m. From the XBT results, all marine mammal sightings occurred in water where the mixing layer was less than 40m deep.

(5). Biological material from the hauls was frozen and returned to the lab. The otoliths and beaks from fish and squids, respectively, will be used to study the relation of otolith/beak size to biomass of specimen.

INCIDENTS AND FAULTS

(1). The foot and head cables for the MWT were mislabeled which resulted in the net being attached improperly.

(2). The Furono net sounder worked well.

(3). The MWT hit the bottom during one trawl haul which resulted in damage to the net.

(4). XBT recording system failed to record three of the 23 launches. In addition, one of the two data tapes "crashed" during a data retrieval exercise.

(5). Ship's labs were extremely neat and clean at start of cruise.

(6). Scientific gear for cruise was removed and laboratories cleaned and tidied at end of cruise.

Appendix 2Z. Cruise report for SWFSC Cruise 0874. (Continued)

Prepared by: Douglas DeMaster — Date: 3-21-84

Approved by: for John F. Carr — Date: 3/21/84
Izadore Barrett
Director, F/SWC

cc: Barrett, F/SWC
Sakagawa, F/SWC1
David Starr Jordan, CPM 443

Distribution for Cruise DS-84-11:

F/SWR:
  Director
  G. Smith

F/SWC:
  I. Barrett
  V. Breda
  L. Farrar (10)
  D. Gittings
  B. Remington
  J. Thrailkill
  L. Vlymen

F/SWC1:
  J. Barlow
  F. Begley (20)
  D. DeMaster (10)
  S. Hawes
  A. Hohn
  R. Lasker
  G. Sakagawa
  P. Smith
  W. Parks

IATTC/F/SWC:
  J. Joseph

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SIO:
  J. McGowan, A-028
  W. Nierenberg, A-010
  R. Cowan, A-008

F/SWR34:
  N. Mendes

F/SWC2:
  R. Shomura

F/SWC4:
  A. Bakun

F/SER:
  J. Brawner

F/NEC2:
  R. Marak

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MEXICO 7, D.F.

Appendix 2AA. Cruise report for SWFSC Cruise 0893.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southwest Fisheries Center
P.O. Box 271
La Jolla, California 92038

Cruise Report Cr. 0893

VESSELS: 1) R/V David Starr Jordan
Albacore Survey Cruise, DS84-08 (179).

2) F/V Steel Fin II
(Commercial albacore gillnet fishing vessel).

CRUISE DATES: Jordan: 8 August - 28 August, 1984.
Steel Fin II: 8 August - 25 August, 1984.

PROJECT: Albacore Population Dynamics.

ITINERARY: Both vessels departed San Diego, CA. 8 August 1984 and proceeded generally west to local fishing grounds where commercial albacore jig boats were reporting good catches. The vessels fished these local banks and the waters just outside the Channel Islands through 25 August. Scientific personnel departed the Steel Fin II and boarded the Jordan to complete cruise objectives and return to San Diego 28 August 1984 (Fig. 1).

OBJECTIVES: (1) Working with the chartered fishing vessel, Steel Fin II, to sample the albacore population in each of several predetermined vertical depth strata with specially designed research gillnets.

(2) To sample the waters in and around the nets with trolled lures and jigs of various sizes and types to determine the minimum and maximum size class of albacore available to that gear.

(3) To evaluate the feasibility of sampling squid from the Jordan using squid machines and monofilament squid gillnets.

(4) To gather data on squid predation by pelagic fish and birds; selected pelagic seabirds to be collected during daylight hours for analysis of feeding habits.

(5) To collect all prescribed environmental, biological and sampling data.

METHODS: In the fishing area, the chartered fishing vessel set and hauled the albacore sampling nets repeatedly in each of four vertical depth strata, both during the day and at night. The albacore population was also sampled with a wide variety of trolling gears by both vessels. On selected nights, the Jordan set and hauled two surface-fishing, monofilament squid gillnets. These nets were deployed and retrieved from the ship's stern using the trawl drum. One squid jigging machine was operated each night the Jordan was drifting. Data on location and time of albacore, skipjack and squid catches were collected for each set as were specimen size, condition and type of gear. Various organ and tissue samples were taken from many specimens.

RESULTS: A total of 12 nighttime and two daytime albacore sampling sets were made at depths ranging from one meter to 20 meters. Samples included 454 albacore, 276 skipjack tuna, several bullet and jack mackerel, four species of shark and various other miscellaneous fishes.

Trolling operations produced 513 albacore and 155 skipjack from the Steel Fin II and 250 albacore and 63 skipjack from the Jordan. Squid nets were set in each of four different areas and the jigging machines were operated whenever the Jordan was drifting overnight. No squid were taken in the sampling nets but two were caught on the jigging machine.

Biological samples included 156 jig-caught and 25 gillnet-caught albacore stomachs, 24 gonad and 24 heart samples for mtDNA analysis, and 14 large albacore heads for otolith studies and various other samples as requested.

Marine mammal and seabird watches were conducted during day light hours. In 98.8 hours observation, approximately 72 marine mammal sightings representing 10 species and several sightings of 45 species of seabirds were documented. A total of 37 CTD casts and 21 XBT traces were taken during and between sampling operations as were sea surface and environmental conditions.

Appendix 2AA. Cruise report for SWFSC Cruise 0893. (Continued)

PERSONNEL: David Starr Jordan

Dr. Norman Bartoo	SWFC, Chief Scientist
Bob Pitman	SWFC
John Michno	SWFC
John Hedgepeth	SWFC
Hannah Bernard	SWFC
Alberto Garces	Spanish Inst. of Oceanography, Madrid
Tom Tumosa	SWFC
Tony Sarain	SWFC

Steel Fin II

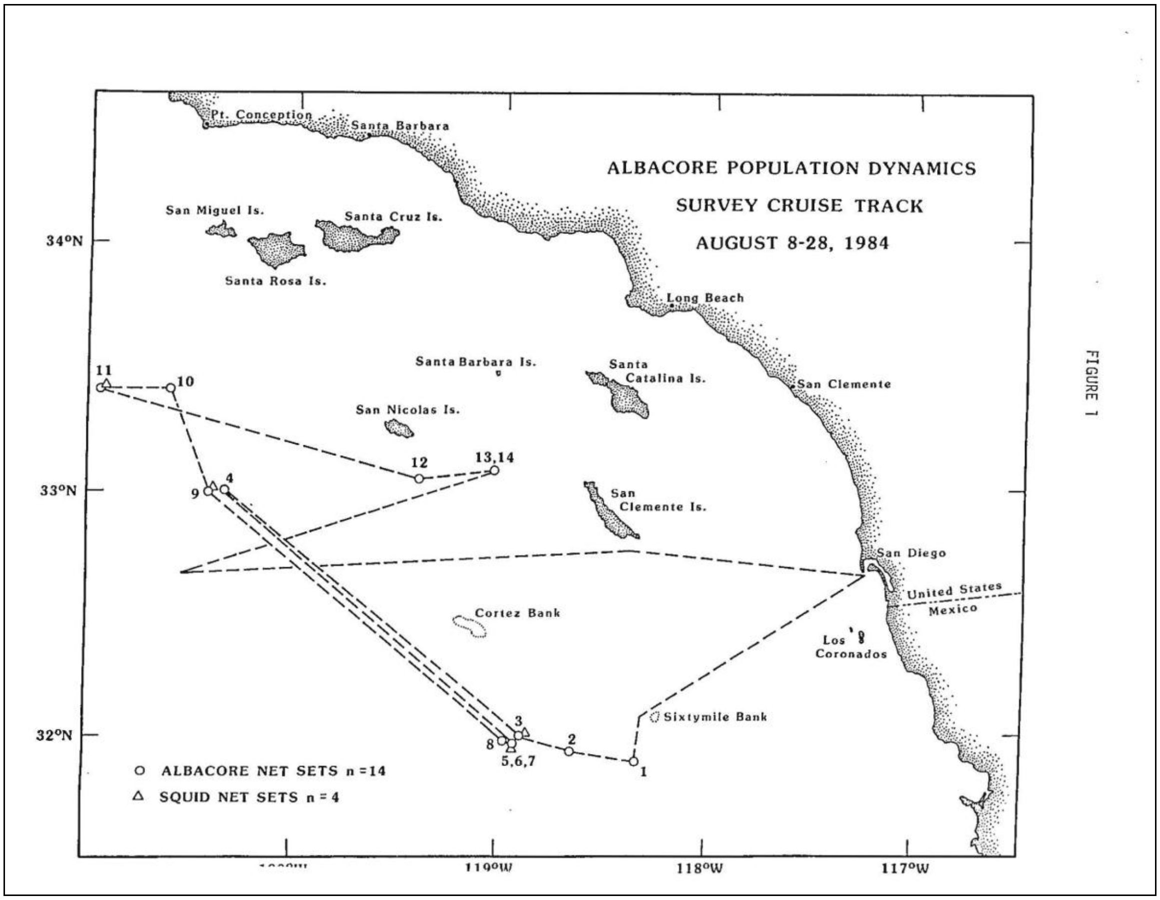
Dave Holts	SWFC, Cruise Leader
Earl Weber	SWFC

Prepared by Dave Holts Dated 10/1/84
Dave Holts
Cruise Leader

Approved by John F. Carr Dated 10/2/84
for Izadore Barrett
Director

Distribution: attached

Appendix 2AA. Cruise report for SWFSC Cruise 0893. (Continued)



Distribution for Cruise DS-84-08:

F/SWR:
- Director
- G. Smith

F/SWC:
- I. Barrett
- V. Breda
- J. Carr
- L. Farrar (10)
- Hitz, CPM12
- R. White
- L. Vlymen

F/SWC1:
- D. Au
- N. Bartoo
- F. Begley (20)
- H. Bernard
- J. Hedgepeth
- D. Holts (10)
- R. Lasker
- W. Parks
- R. Pitman
- S. Reilly
- G. Sakagawa
- P. Smith
- E. Weber

IATTC/F/SWC:
- J. Joseph

Scientific Publications Office:
- W. Hobart, F/S23

F/SWC2:
- R. Shomura

F/SWC3:
- W. Lenarz

F/SWC4:
- A. Bakun

F/SER:
- J. Brawner

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- K. Mais
- Marine Technical Information Center

Mr. Craig Fusaro
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Appendix 2AB. Cruise report for SWFSC Cruise 0895.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southwest Fisheries Center
P.O. Box 271
La Jolla, CA 92038

CRUISE REPORT: HARBOR PORPOISE SURVEY

VESSEL:
R/V David Starr Jordan, Cruise No. DS-84-09
Southwest Fisheries Center (SWFC) Marine Mammal Cruise No. 895

DATES:
4 to 15 September 1984

PROJECT:
Harbor Porpoise Survey

ITINERARY:

4 September 1984,	0600	Left San Diego, Nimitz Marine Facility
5 September	0645	Arrived at Point Conception
9 September	1930	Turned at Cape Flattery
14 September	1130	Arrived at Point Conception
15 September	0700	Arrived San Diego, Nimitz Marine Facility

OBJECTIVES:
This report describes the survey procedures and preliminary results from the first Southwest Fisheries Center (SWFC) survey for harbor porpoises (Phocoena phocoena). The David Starr Jordan, a 50-meter NOAA research vessel, was used to survey a coastal strip from Point Conception in central California to Cape Flattery in northern Washington. Sightings were recorded for all cetacean species seen along this strip, plus those cetacean sightings made in transit between San Diego and Point Conception. While in transit to Point Conception, we delivered a pinniped research party lead by Sandra Hawes (SWFC) to Santa Barbara Island. The observation and recording procedures used were a slight modification of procedures used in many previous SWFC marine mammal surveys. These procedures are reviewed briefly below, and the modifications will be described in detail. This ship survey was coordinated with aerial and ground counts of harbor porpoise in a program lead by Terry Jackson, NOAA Corps, SWFC. Results from the aerial survey will be reported separately.

METHODS:
During the harbor porpoise survey, the Jordan followed a coastal route from Point Conception to Cape Flattery, and back. During daylight hours, the ship stayed at a distance of 3/4 to 1 nautical mile from the coast or followed the 10-fathom isobath (whichever was deeper). The cruise track is shown in Fig. 1. At night, or when weather prevented surveys, the ship moved further offshore, but continued in the same direction. The ship's speed was maintained at approximately 9.5 to 10 knots. The ship was stopped or was turned from the cruise track only when additional time was required to make species identifications or group size estimates.

Five observer positions were used: right and left observers using 25-power binoculars, right and left observers using 7-power binoculars, and a recorder who searched with the naked eye when not recording data. All observers were stationed on the flying bridge, with the 7-power positions standing inboard of the 25-power positions. Positions were shifted every 30 minutes to avoid fatigue. On the San Diego to Cape Flattery leg, Barlow, Chivers, Hohn, Read and Scott rotated among the two 25-power binoculars and the recorder position. Mizroch, Szczepaniak, Taylor and Weber shifted between the two 7-power binocular stations. On the return leg, the 9 observers rotated among all 5 positions. Observers were instructed to search between 0 and 90 degrees on their respective sides. All observers were informed when a sighting was made, and the observers were free to discuss information pertaining to species identification. Individual estimates of species proportions and school size estimates were kept confidential. Search effort was discontinued several times due to poor sighting conditions. In general, effort was terminated when visibility was reduced to less than 1 nautical mile due to fog or when the sea state was greater than a Beaufort 5.

All cetacean sightings were recorded on standard SWFC forms (the Research Ship Marine Mammal Sighting Record). A "first page" was filled out by the recorder for each sighting , and a "continuation sheet" was filled out by each observer who saw the animals. Search information was recorded on another standard form (the Daily Effort Record) by the recorder. At the end of each survey day, the cruise leader and volunteers from the scientific party transferred position, temperature, and ship speed information from a computer print-out to the appropriate fields on the "first page" of the Marine Mammal Sighting Record and to the Daily Effort Record. Confidential school size and species proportion estimates from individual "continuation sheets" were transferred to the "first page" of the Sighting Record.

Special Procedural Modifications: Usual survey procedures were modified for surveying harbor porpoise. Future data users should give special attention to these differences.

1) Five observers were on duty whenever the team was "on effort" instead of the usual three. The computerized data base will only indicate who was on the two 25-power binoculars and who was in the recorder position. The observer numbers for those in 7-power binocular positions are recorded on the sighting forms and on the effort log.

2) The hierarchy of end-of-leg codes was different. Because the vessel was following the coastline instead of a constant compass course, the ship was turning almost constantly. For this reason, legs were not terminated due to change in course or sun angle. End-of-leg code 1 was not used.

3) Because sightings were being made close to shore, depth information was recorded on the sighting form. This represents the depth of the water under the vessel at the time of the sighting. This information is not coded into the computerized data base.

4) Because the ship usually traveled within 1 mile of the coast, the strip width of the search was asymmetrical. Sightings were made at much greater perpendicular distance from the offshore side. In practice, observers shortened their search distance when looking for harbor porpoise because they are hard to sight. Because of this, search

efficiency for other species was probably lower than during the usual cetacean surveys in the eastern tropical Pacific or in the southern California bight.

RESULTS:

The location of Phocoena sightings are given in Fig. 2. The location of non-Phocoena sightings are given in Table 1. If the number of sightings of each species is stratified by sea state at the time of the sighting (Table 2), harbor porpoise appear to be sighted more frequently in calm seas. When the percentage of Phocoena sightings at each sea state is compared to the percentage of sighting effort spent at those sea states (Table 3), we can see that sighting efficiency for Phocoena decrease rapidly as sighting conditions worsen. If Beaufort 0 is given a relative efficiency of 1.0, the relative sighting efficiencies at Beauforts 1, 2, 3, 4, and 5 are 0.51, 0.23, 0.18, 0.13, and 0.05 (respectively).

Most of the observers on this cruise had previous experience surveying for Phocoena (observer numbers 30, 31, 32, and 34) or experience surveying for other delphinids (observer numbers 14, 15, and 25). Total number of Phocoena sightings showed little difference between individual observers in these two groups (Table 4).

One of the goals of this cruise was to determine the inshore/offshore gradient in harbor porpoise distributions. A rough look at this is possible by tallying the number of sightings made on the inshore and offshore sides of the vessel (Table 5). Preliminary results indicate that approximately equal numbers were seen on each side. Additional work will be needed to determine inshore/offshore gradients.

Whenever possible, observers recorded the direction of movement of the marine mammals that they sighted at the time of sighting. The intent was to look at possible migration patterns and to determine whether harbor porpoise were reacting to the presence of the vessel. When the ship was traveling north, the predominate direction of harbor porpoise movement was south; when the ship headed south, the predominate direction of harbor porpoise movement was north (Table 6). This is probably evidence that harbor porpoise were reacting to the presence of the ship prior to being detected by observers. After detection, they were often seen to move away from the ship. Estimation of harbor porpoise abundance from data collected on this cruise may underestimate the true abundance due to this avoidance of ships.

RECOMMENDATIONS FOR FUTURE RESEARCH:

Being the first such cruise, we learned a great deal about surveying for harbor porpoise. Specific recommendations for changes on future harbor porpoise surveys are:

1) A new sighting form and data base should be developed exclusively for harbor porpoise. The data coding methods used on this cruise were far too time consuming to allow for the very high number of sightings (up to 99 in one day). Since it is rare that more than one

observer will see a group, multiple school size estimates are not usually available. Filling out the continuation sheets and sketching the animals took up the most time and actually hindered the collection of data (several times we had to discontinue effort just to catch up with paperwork). Also, several data fields should be added. The new form should allow up to 6 observer positions for harbor porpoise cruises, and it should have special fields for entering depth and direction-of-movement information.

2) Data from this cruise provided very little information about inshore/offshore gradients in harbor porpoise distribution. A more concerted effort over a broader strip will have to be made on future cruises if a population estimate is desired.

3) One of the most notable features found on this cruise was the patchiness of harbor porpoise distributions. Future cruises should help to determine whether these areas of high abundance are permanent and whether they are associated with distinct physical features such as rivers, bottom topography, or bottom type (sandy, rocky, etc.). Also, surveys during different seasons may be useful in determining movement or migration patterns, and thus they may tell us something about stock structure.

4) Avoidance of the ship by harbor porpoise may be a major problem. Because most Phocoena are not detected until they are relatively close to the vessel and because they seem to be reacting to the ship before they are detected, line transect methods may underestimate harbor porpoise abundance. The extent of this problem may be investigated using land-based observers on coastal pinnacles. Harbor porpoise positions could be plotted with a theodolite before, during and after the passage of a research vessel.

DISPOSITION OF DATA

Marine mammal sighting forms and effort logs were given to Al Jackson (SWFC) for editing and entry into a data base. Data on sea surface temperature and salinity and one digitized XBT data assette were retained by the cruise leader for future use.

SCIENTIFIC PERSONNEL:

Jay Barlow	SWFC (chief scientist)
Aleta Hohn	SWFC
Susan Chivers	SWFC
Barbara Taylor	Northwest and Alaska Fisheries Center
Sally Mizroch	Northwest and Alaska Fisheries Center
Michael Scott	Inter-American Tropical Tuna Commission
Marc Weber	Oceanic Society
Izadore Szczepaniak	California Academy of Science
Andrew Read	University of Guelph, Canada

Appendix 2AB. Cruise report for SWFSC Cruise 0895. (Continued)

Prepared by Jay Barlow
Jay Barlow
Chief Scientist

Dated: 12 October 1984

Approved by John F. Carr
Izadore Barrett
Director

Dated: 10/31/84

Distribution: (pp.6 and 7)

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Table 1. Time and location of non-Phocoena cetacean sightings. Sea state refers to the estimated Beaufort number at the time of the sighting. Group size is the median of the independent estimates by each observer who recorded group size.

DATE	TIME	SPECIES	LATITUDE		LONGITUDE		SEA STATE	EST. GROUP SIZE
9/4	0740	unidentified whale	32°	45'N	117°	31'W	2	1
4	0748	unidentified dolphin	32°	46'	117°	32'	2	70
4	0753	Delphinus delphis	32°	45'	117°	31'	2	150
4	1153	Grampus griseus/ Tursiops truncatus	33°	07'	118°	17'	2	15
4	1256	unidentified whale	33°	14'	118°	31'	3	1
4	1320	unidentified dolphin	33°	15'	118°	33'	3	1
4	1746	Delphinus delphis	33°	33'	119°	06'	3	137
9/5	0640	Delphinus delphis	34°	26'	120°	27'	2	50
5	0953	Lagenorhynchus obliquidens	34°	51'	120°	39'	2	30
9/7	0714	Phocoenoides dalli	39°	27'	123°	49'	2	12
7	1023	unidentified porpoise	39°	53'	123°	58'	2	1
7	1620	Orcinus orca	41°	08'	124°	34'	2	3
7	1820	Eschrichtius robustus	40°	45'	124°	17'	2	3
9/8	0835	Phocoenoides dalli	42°	48'	124°	41'	3	4
8	0930	Megaptera novaeangliae	42°	53'	124°	40'	1	3
8	1010	unidentified porpoise	42°	53'	124°	33'	2	1
8	1806	Balaenoptera acutorostrata	44°	04'	124°	09'	2	1
9/9	1144	unidentified whale	47°	03'	124°	14'	2	1
9	1731	Orcinus orca	48°	02'	124°	45'	1	15
9/10	0810	Orcinus orca	46°	14'	124°	14'	2	4
10	1814	Eschrichtius robustus	44°	37'	124°	07'	2	2
9/11	0747	Balaenoptera acutorostrata	42°	55'	124°	31'	2	1
11	0823	Megaptera novaeangliae	42°	50'	124°	37'	2	8
11	0845	Phocoenoides dalli	42°	48'	124°	39'	2	16
11	0914	Megaptera novaeangliae	42°	45'	124°	38'	2	1
11	0915	Phocoenoides dalli	42°	45'	124°	38'	2	5
11	1729	Eschrichtius robustus	41°	36'	124°	09'	3	3
11	1733	Eschrichtius robustus	41°	36'	124°	09'	3	2
11	1756	unidentified whale	41°	32'	124°	07'	3	1
11	1828	Eschrichtius robustus	41°	26'	124°	06'	3	1
11	1843	Megaptera novaeangliae	41°	23'	124°	07'	3	17
9/12	0630	Balaenoptera musculus	39°	59'	124°	10'	3	1
12	0707	Phocoenoides dalli	39°	59'	124°	10'	3	7
12	1122	unidentified whale	39°	30'	123°	39'	2	1

12	1710	Balaenoptera musculus	38°	37'	123°	24'	4	1
9/13	1140	Balaenoptera acutorostrata	36°	36'	121°	58'	1	1
13	1243	Balaenoptera acutorostrata	36°	27'	121°	57'	1	2
13	1343	Grampus griseus	36°	16'	121°	54'	1	1
13	1353	Phocoenoides dalli	36°	16'	121°	54'	1	6
13	1523	Balaenoptera acutorostrata	36°	08'	121°	40'	1	1
13	1535	Grampus griseus	36°	06'	121°	39'	1	15
13	1616	unidentified dolphin	36°	03'	121°	37'	1	2
13	1753	unidentified porpoise	35°	50'	121°	26'	1	2
13	1800	Phocoenoides dalli	35°	50'	121°	24'	1	7
13	1806	Balaenoptera acutorostrata	35°	49'	121°	24'	1	1
13	1833	Phocoenoides dalli	35°	47'	121°	22'	1	4
9/14	0748	Phocoenoides dalli	34°	48'	120°	39'	1	2
14	0833	Lagenorhynchus obliquidens	34°	44'	120°	38'	1	11
14	1015	Tursiops truncatus	34°	30'	120°	31'	3	14
14	1420	unidentified whale	34°	00'	119°	58'	4	1
14	1438	Delphinus delphis	33°	58'	119°	55'	4	78
14	1534	Megaptera novaeangliae	33°	51'	119°	47'	1	1
14	1555	unidentified whale	33°	48'	119°	44'	1	2
14	1641	Megaptera novaeangliae	33°	48'	119°	37'	3	1
14	1700	Tursiops truncatus	33°	43'	119°	34'	3	6
14	1710	unidentified whale	33°	42'	119°	32'	3	1
14	1719	unidentified whale	33°	42'	119°	30'	3	1
14	1735	unidentified whale	33°	42'	119°	28'	3	1
14	1735	Delphinus delphis	33°	42'	119°	28'	3	55
14	1804	Delphinus delphis	33°	40'	119°	23'	3	750
14	1816	Delphinus delphis	33°	39'	119°	21'	4	25

Table 2. Number of cetacean sightings stratified by sea state at the time of the sighting.

Species	Beaufort Sea State 0	1	2	3	4	5
Delphinus delphis			2	3	2	
Grampus griseus		2	1			
Tursiops truncatus			1	2		
Orcinus orca		1	2			
Lagenorhynchus obliquidens		1	1			
Eschrictius robustus			2	3		
Balaenoptera acutorostrata		5	1			
Balaenoptera musculus				1	1	
Megaptera novaeangliae		2	2	2		
Phocoenoides dalli		4	3	2		
Phocoena phocoena	17	140	94	35	13	3
unidentified dolphin		2	3	3		
unidentified whale		1	3	3	1	

Table 3. Percentage of *Phocoena* sightings made at various sea states, and percentage of searching time spent at those sea states from 5 September to 13 September.

Beaufort Sea state	Percentage of *Phocoena* sightings	Percentage of Searching effort
0	5.6 %	1.6 %
1	46.4	26.1
2	31.1	38.3
3	11.6	18.9
4	4.3	9.2
5	1.0	5.9
TOTAL	100.0 %	100.0 %

Table 4. Number of *Phocoena* sightings made by each observer.

Observer #	# of Sightings
14	35
15	31
25	51
29	32
30	39
31	39
32	27
33	14
34	32

Table 5. Number of *Phocoena* sightings made on the inshore and offshore sides of the vessel.

Direction of Ship Movement	Inshore side	Offshore side	Dead center
Heading North Sept. 5 - 9	56	44	4
Heading South Sept. 10 - 13	83	98	16
TOTAL	139	142	20

Table 6. Direction of *Phocoena* movement at the time of sighting. Excluded are sightings for which direction of movement was not recorded or was not the same for all group members.

Direction of Ship Movement	Direction of *Phocoena* Movements N	E	S	W
North Sept. 5 - 9	2	5	68	5
South Sept. 10 - 13	81	12	18	25
TOTAL	83	17	86	30

Appendix 2AB. Cruise report for SWFSC Cruise 0895. (Continued)

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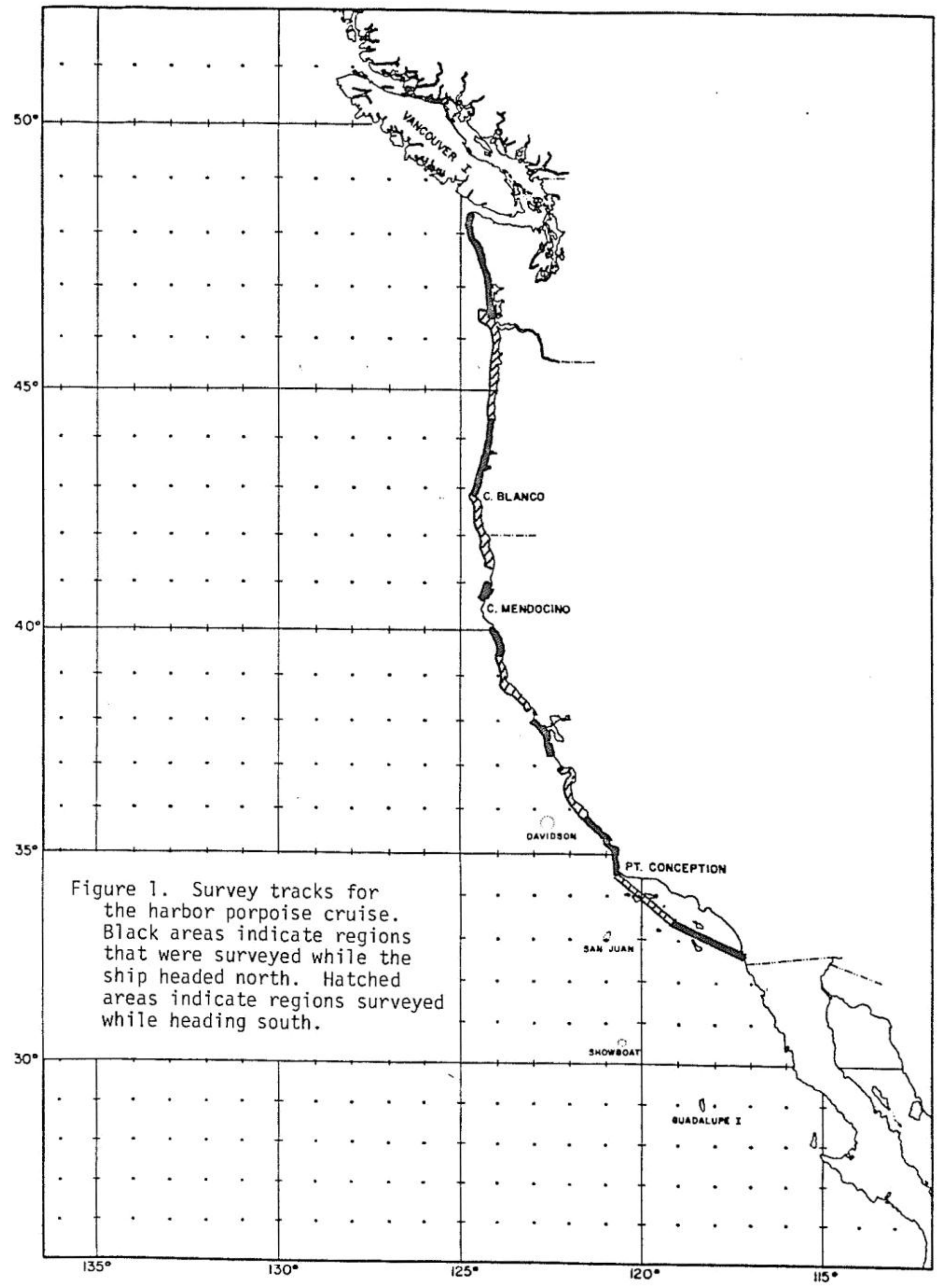

Figure 1. Survey tracks for the harbor porpoise cruise. Black areas indicate regions that were surveyed while the ship headed north. Hatched areas indicate regions surveyed while heading south.

Appendix 2AB. Cruise report for SWFSC Cruise 0895. (Continued)

16

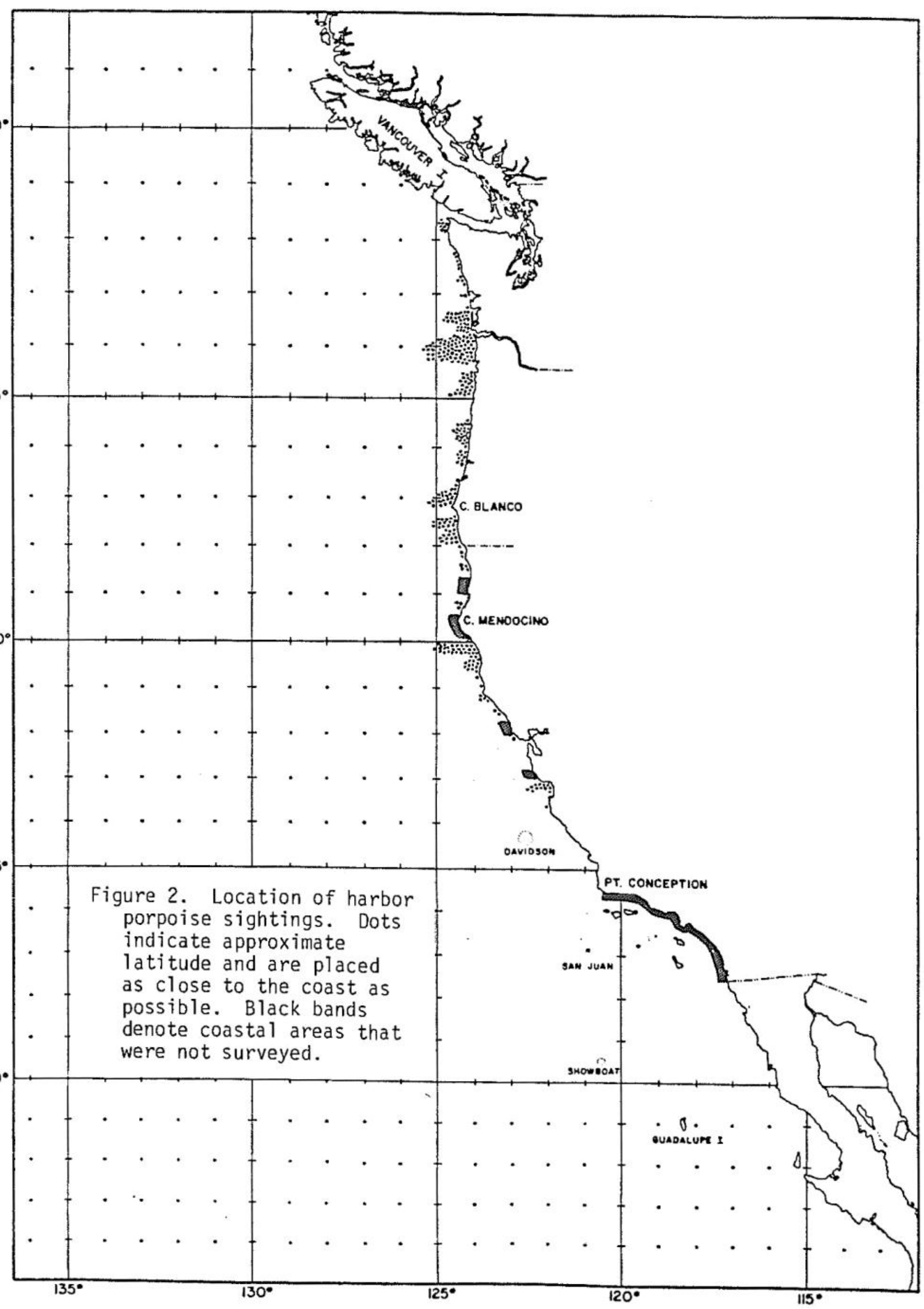

Figure 2. Location of harbor porpoise sightings. Dots indicate approximate latitude and are placed as close to the coast as possible. Black bands denote coastal areas that were not surveyed.

Appendix 2AC. Cruise report for SWFSC Cruise 0905.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southwest Fisheries Center
P.O. Box 271
La Jolla, California 92038

February 8, 1985 F/SWC1

CRUISE REPORT

VESSEL:

R/V David Starr Jordan, Cruise No. DS-84-12 (183)
Southwest Fisheries Center (SWFC) Marine Mammal Cruise No. 905

DATES:

5-19 December 1984.

PROJECT:

Pilot whale survey.

CRUISE ITINERARY:

5 December 1984, 0700	Left San Diego, Nimitz Marine Facility
19 December 1984, 0015	Arrived in San Diego, Nimitz Marine Facility

SCIENTIFIC PERSONNEL:

Aleta A. Hohn	SWFC (Chief Scientist)
Jay Barlow	SWFC
Susan J. Chivers	SWFC
Stephanie Sexton	SWFC
Michael D. Scott	Inter-American Tropical Tuna Commission
Omar Vidal	Escuela de Ciencias Maritimes Inst. Technologic de Monterrey (Mexico)

OBJECTIVES:

To determine the distribution and abundance of pilot whales in the Southern California Bight (SCB).

To survey all cetaceans in the SCB.

METHODS:

The initial plan was to conduct the survey along 11 predetermined track lines approximately perpendicular to the coast line (bearing 045° M), beginning about 40 nm west of San Diego (Fig. 1). Each subsequent track line was parallel to the initial one at a perpendicular distance of 15 nm, with one end 10 nm from the coast and the other extending up to 100 nm offshore or at least to the edge of the Tanner Basin. Each track line was scheduled to take about one survey day with 9 1/2 daylight hours, except for number III which required several hours longer. The remaining sea time was scheduled for intensive surveys in areas of expected high densities of pilot whales, particularly Santa Catalina and San Clemente Islands, or any other area where pilot whales had been seen during the first part of the survey.

During the cruise, the cruise plan had to be changed. Several days and partial days were lost due to poor sighting conditions (bad weather). Only five of the eleven planned transect lines were completed, three were partially completed, and the remaining three were not surveyed at all. Two consecutive days were spent anchored in the lee of Catalina Island because of strong winds. The following day we surveyed along a direct route from Catalina Island to the beginning of the next track line (near Anacapa Island). We spent one day surveying an area not initially scheduled (the south sides of Santa Rosa and Santa Cruz islands) because it was the only area with good sighting conditions on that day. The five completed track lines were surveyed during the first five days of the cruise. Figure 2 shows the actual cruise track.

All observers received training before the cruise. This included a review of the type of data to be collected and the procedure for collecting it, the format of the sighting code forms, the data collection codes, and the procedure for completing the "continuation sheet". Michael Scott (IATTC) provided species' identification training for new and less experienced observers and school size estimation training for all of the observers.

During the survey, three observers were on effort; two observers were on 25x binoculars mounted on the right and left sides of the flying bridge and the third, the "recorder," used 7x binoculars to watch the track line. Observers rotated positions every 30 minutes, moving from the right 25x binoculars, to the recorder position, to the left 25x binoculars. All cetacean sightings were recorded on the "Research Ship Marine Mammal Sighting Record" and search effort was recorded on the "Research Ship Marine Mammal Daily Effort Record," both standard SWFC survey forms. The observers reached a consensus on species identification, but school size and species proportion estimates were made independently. Each observer recorded species' diagnostic features, school size estimates, and behavioral observations on a sighting record "continuation sheet."

Additional data collected included vessel speed, surface and subsurface water temperature, salinity, and sun position.

RESULTS:

There were 127 sightings of 11 species of dolphin schools or whales. Only one school of pilot whales was sighted; the group contained 10 animals (median school size estimate), including one calf, and was sighted at the northwest end of San Clemente Island. Notably, no pilot whales were seen around Santa Catalina Island. The common dolphin, Delphinus delphis, was the most commonly sighted species (50 sightings of pure and mixed-species schools), and they were widely distributed throughout the SCB. A large number of fin whales, Balaenoptera physalus, was also seen (46 whales in 12 sightings). Most of the whales were sighted along the shoreward edge of the Tanner Basin and the area south of San Nicolas Island. An additional 7 large whales were sighted but not identified in these same areas. An unusual species sighted was the false killer whale, Pseudorca crassidens. This species has not been seen in previous SWFC cetacean surveys in the SCB. A daily summary of all sightings is provided in Table 1.

Vessel speed varied from 8.2 to 12.1 knots, but the majority of time was spent at speeds of 10 to 11.5 knots. The lowest and highest sea surface temperatures (SSTs) were 54.7° and 61.2° F. The colder waters occurred offshore near or over the Tanner Basin. The SSTs in other areas were 58-61° F. Twenty expendable bathythermographs (XBT's) were launched, generally one each morning and afternoon. The depth of the mixing layer was approximately 40 m.

DISCUSSION:

Although the full set of transect lines was not surveyed, enough area was covered for us to conclude that pilot whales were not abundant in the SCB during the time of this cruise. These results were corroborated by a contractor who surveyed by shore, small boat, and aircraft around Santa Catalina and San Clemente islands from late November through the end of the cruise.

Historically, the pilot whales migrated into the SCB predominantly during December and stayed through February to feed on spawning squid. In the winter of 1975-1976 about 500 animals were sighted in the SCB during an aerial survey (Dohl et al. 1978), and in the winter of 1980-1981 316 whales were estimated to occur around Catalina Island on the basis of another aerial survey (Miller et al. 1983, SWFC Admin. Rep. LJ-83-13C). One to two hundred animals were estimated to occur around Catalina Island during the winter of 1982-1983 (S. Shane, pers. comm.) and they arrived later than expected (S. Shane 1983, SWFC Admin. Rep. LJ-84-28C).

This is the second consecutive year that pilot whales have been seen in very small numbers (fewer than 20) in the SCB. During the past two years, the squid have also been scarce. The virtual absence of both species may be related to the occurrence of El Niño which has raised water temperatures. In the winter of 1983-84, only one small group of pilot whales was seen near Catalina Island and they did not appear until 28 January 1984 (Shane 1984, SWFC Admin. Rep. LJ-84-28C), approximately two months later than usual. It is possible that pilot whales will arrive in greater numbers in January or February, 1985.

Prepared by Aleta Hohn Dated: 8 Feb 85

Aleta Hohn
Chief Scientist

Approved by Izadore Barrett Dated: 8/II/85

Izadore Barrett
Director

Distribution: Pages 8 and 9

Table 1. Daily sightings of each species.

Species	December														
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Odontocetes															
Pure-species schools:															
Globicephala macrorhynchus	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Delphinus delphis	4	4	2	7	4	2	2	-	-	3	10	3	6	1	48
Grampus griseus	3	1	1	-	-	-	-	-	-	-	1	1	6	-	13
Lagenorhynchus obliquidens	2	1	-	2	-	-	1	-	-	-	5	-	-	-	11
Phocoenoides dalli	-	-	-	-	-	-	-	-	-	-	-	1	2	-	3
Tursiops truncatus	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Pseudorca crassidens	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Lissodelphis borealis	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Unidentified dolphins	1	-	-	4	2	1	-	-	-	-	3	-	1	-	12
Mixed-species schools:															
T. truncatus/G. griseus	-	-	1	-	-	-	-	-	-	2	-	-	-	-	3
D.delphis/P. dalli	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
D. delphis/L. obliquidens/ G. griseus	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Mysticetes															
Balaenoptera physalus	-	-	-	-	4	3	5	-	-	-	-	-	-	-	12
Balaenoptera acutorostrata	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Megaptera novaeangliae	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Unidentified small whales	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Unidentified large whales	-	3	-	1	2	-	4	-	-	1	-	-	1	1	13
Unidentified cetaceans	-	-	-	1	-	-	-	-	-	-	1	-	1	-	3
TOTAL	10	10	6	16	12	7	14	0	0	6	20	5	19	2	127

Appendix 2AC. Cruise report for SWFSC Cruise 0905. (Continued)

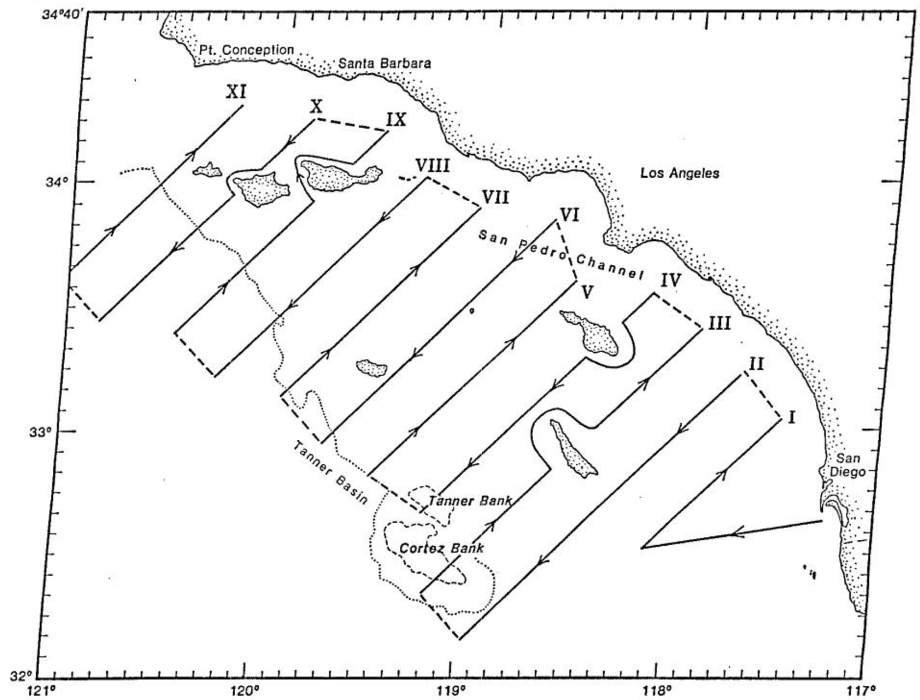

Figure 1. Proposed track lines for the pilot whale survey. The arrows indicate the expected direction of travel. The numerals mark the 11 track lines.

Appendix 2AC. Cruise report for SWFSC Cruise 0905. (Continued)

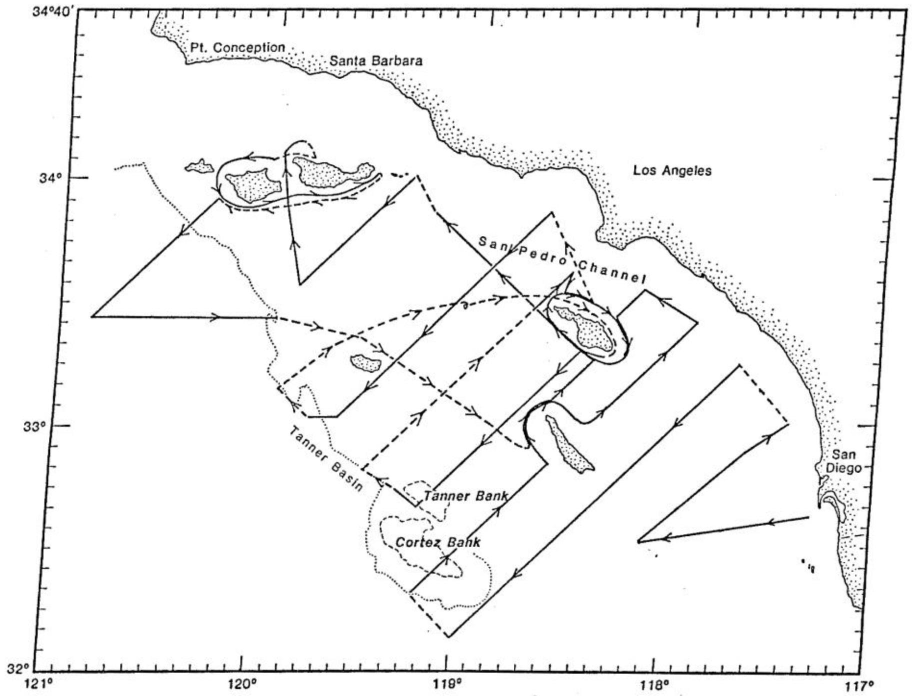

Figure 2. The actual track lines during the pilot whale survey. The arrows indicate the direction of travel. The solid lines indicate "on effort" surveying; dashed lines indicate time "off effort" due to bad weather or night travel.

Appendix 2AC. Cruise report for SWFSC Cruise 0905. (Continued)

DISTRIBUTION for Cruise DS-84-12:

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- W. Parks
- G. Sakagawa
- P. Smith

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- B. Taylor
- R. DeLong

F/SWC4:
- A. Bakun

IATTC:
- J. Joseph

SIO:
- J. McGowan, A-028
- W. Nierenberg, A-010

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- J. Angelovic

F/M4:
- R. Roe

F/SWR:
- C. Fullerton
- G. Smith

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- N. Mendes

F/SER:
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Ms. Susan Shane
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Santa Cruz, California 95064

Appendix 2AD. Cruise report for SWFSC Cruise 0910.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southwest Fisheries Center
P.O. Box 271
La Jolla, CA 92038

February 21, 1985 F/SWC1

CRUISE REPORT

VESSEL:
NOAA R/V McArthur, Cruise No. AR-85-01
Southwest Fisheries Center, Marine Mammal Cruise No. 910

DATES:
24 January to 9 February 1985

PROJECT:
Harbor Porpoise Survey

ITINERARY:

24 January 1985,	0900	Departed Seattle, Pacific Marine Center
29 January	0900	Arrived at San Francisco
30 January	0800	Departed San Francisco
06 February	1100	Touch-and-go at Monterey, CA
09 February	1100	Arrived San Diego, Nimitz Marine Facility

SCIENTIFIC PERSONNEL:

Leg 1, Seattle to San Francisco

Jay Barlow	SWFC	(chief scientist)
Aleta Hohn	SWFC	
Barbara Taylor	Northwest and Alaska Fisheries Center, NMML	
Joanna Flanders	Northwest and Alaska Fisheries Center, NMML	

Leg 2, San Francisco to Monterey

Jay Barlow	SWFC	(chief scientist)
Susan Chivers	SWFC	
Jeanie Wexler	SWFC	
Sandra Hawes	SWFC	
Sandy Diamond	California Fish and Game	
Greg Silber	Univ. of Cal., Santa Cruz	
Michael Newcomer	Moss Landing Marine Lab	
Keiko Sechiguchi	Moss Landing Marine Lab	

Leg 3, Monterey to San Diego

Jay Barlow	SWFC	(chief scientist)
Susan Chivers	SWFC	
Jeanie Wexler	SWFC	
Sandy Diamond	California Fish and Game	

OBJECTIVES:

This report describes the survey procedures and preliminary results from the second Southwest Fisheries Center (SWFC) survey for harbor porpoises (Phocoena phocoena). The purpose of the cruise was to survey for harbor porpoise along a coastal strip from Cape Flattery in northern Washington to Point Conception in central California. The intent was to gather additional data for harbor porpoise population estimation and to gather information on seasonal changes in harbor porpoise distribution. A secondary objective was to survey the waters around Santa Catalina Island for pilot whales. In addition to harbor porpoise and pilot whales, sightings were to be recorded for all other cetacean species.

METHODS:

During the harbor porpoise survey, the McArthur followed a coastal route from Cape Flattery to Point Conception (Fig. 1). The coastal strip from Point Reyes to Point Sur in California (Fig. 2) was given more complete coverage than other areas. During daylight hours, the ship typically followed the 10-fathom isobath, while maintaining 3/4 mile from the coast and 1/2 mile from any navigation hazards. Between Point Reyes and Point Sur, the 50-fathom isobath was also surveyed. At night or when weather prevented surveys, the ship either anchored, followed a box pattern, or steamed to the starting point of the next day's survey. The ship's speed was maintained at approximately 9.0 to 11.5 knots. The average speed for each day (Table 1) was calculated by dividing distance-made-good by transit time for straight segments of the cruise track. The ship was stopped or was turned from the cruise track only when additional time was required to make species identifications or group size estimates.

Surveys for harbor porpoise consisted of a team of either 3 or 5 observers searching with 7-power hand-held binoculars and by unaided eye. All observers were stationed on the flying bridge. During the first leg (Seattle to San Francisco) and last leg (Monterey to San Diego) of the cruise, searching teams consisted of 3 observers. Additional observers were aboard for the San Francisco to Monterey leg, and the number of observers searching at one time was increased to 5. In both configurations, the two observers on the far right and left searched with 7x binoculars from straight ahead to 90° on their side of the vessel. If 5 observers were on duty, the inside observers on the right and left searched with 7x binoculars from straight ahead to 45° on their side of the vessel. The middle observer was the data recorder and searched by naked eye for porpoise that surfaced close to the vessel. Personnel in each position were changed every 30 minutes to avoid fatigue.

During harbor porpoise surveys, sightings of other cetaceans were recorded as being "off effort". In cetacean surveys by the SWFC, "effort" has been defined as two observers searching with 25x binoculars and a recorder "guarding the trackline". When searching for harbor porpoise, we only used 7x binoculars and were looking relatively close to the vessel for a very specific search image. Sighting efficiency for other species was much lower than when using standard searching methods, which is why other sightings were not recorded as "on effort".

Surveys for pilot whales were conducted using 3 observers: two searching with 25x binoculars and one recorder who searched with 7x binoculars and by unaided eye. Search patterns and position rotations were the same. Sightings of other cetacean species were recorded as being "on effort".

During both types of surveys, all observers were informed when a sighting was made, and the observers were free to discuss information pertaining to species identification. Individual estimates of species proportions and school size estimates were kept confidential. Search effort was discontinued several times due to poor sighting conditions. In general, effort was terminated when visibility was reduced to less than 1 nautical mile due to fog or when the sea state was greater than a Beaufort 5.

Harbor porpoise sightings and searching effort information was coded on the "Research Vessel Harbor Porpoise Sighting and Effort Record". Gray whale sightings were too numerous to record individually, but a running tally was kept for each day's sightings. All other cetacean sightings were recorded on the "Research Ship Marine Mammal Sighting Record". The first page of this record was filled out by the recorder after a sighting, and a continuation page was filled out by each observer who saw the animals. During the pilot whale survey, search information was recorded on the "Daily Effort Record" by the recorder. Position information was provided by the ship's chief survey technician who used land fixes taken approximately every half hour. Sea surface temperature was measured using a calibrated bucket thermometer. In order to allow future data analysis by line-transect methods, sighting angles and distances were estimated for each group of animals. Sighting angles were estimated using a protractor mounted in front of the observers or from a graduated collar on the 25x binoculars. Radial distances were estimated by eye for harbor porpoise sightings since most of these were within 400 meters. When 25x binoculars were used, distances were estimated using ocular reticles. At the end of each survey day, the cruise leader and volunteers from the scientific party transferred position, temperature, and ship speed information to the appropriate fields on the data records.

RESULTS:

The location of *Phocoena* sightings are shown in Figs. 1 and 2. The location of all other cetacean sightings are given in Table 2. The number of sightings of each species, stratified by sea state at the time of the sighting, is given in Table 3. As on the previous harbor porpoise cruise, harbor porpoise appeared to be sighted more frequently in calm seas. When the percentage of *Phocoena* sightings at each sea state is compared to the percentage of sighting effort spent at those sea states (Table 4), sighting efficiency for *Phocoena* appears to decrease rapidly as sighting conditions worsen. If Beaufort 0 is given a relative efficiency of 1.0, the relative sighting efficiencies at Beauforts 1, 2, 3, 4, and 5 are 0.21, 0.06, 0.05, 0.03, and 0.05 (respectively). These relative efficiencies must be interpreted with some caution because they may only indicate a tendency for harbor porpoise to inhabit more sheltered waters. Also the sample size at Beaufort 0 is very small and all the sightings at that sea state occurred during one 30-minute period.

A major goal of this winter survey was to determine whether the distribution of harbor porpoise changes seasonally. Data from a previous cruise (DS-84-09, Sept. 1984) indicated four areas of relatively high abundance: in northern Oregon near the mouth of the Columbia River, at Cape Blanco, just south of Cape Mendocino, and in the Santa Cruz-Monterey Bay region. During this cruise, harbor porpoise were abundant in only two areas: Cape Blanco and south of Cape Mendocino. Fewer harbor porpoise were seen in the Santa Cruz to Monterey area than had been seen in September despite a greater amount of searching time, and we had very few sightings in northern Oregon around the mouth of the Columbia River. Sighting conditions were approximately equal for the two cruises. These are preliminary indications that large scale seasonal movements of harbor porpoise may take place along the west coast. These result corroborate the observations made by Barbara Taylor (NMML, pers. comm.), who found very low abundance of harbor porpoise in northern Oregon in autumn.

Another goal of this cruise was to determine the inshore/offshore gradient in harbor porpoise distributions. The intent was to survey along the 50-fathom isobath in an area of high harbor porpoise abundance in order to compare the number of sightings with the number made along the 10-fathom line in the same area. Unfortunately, the area chosen (Point Reyes to Monterey) proved to be a relatively low density area at the time of our cruise. Despite small sample sizes, a pattern of lower off-shore abundance was evident (Fig 2). Only two harbor porpoise sighting was made along the 50-fathom curve, one of which was at a point where the 50-fathom isobath was very close to the coastline. Heavy winds prevented us from returning to Cape Mendocino and repeating this experiment in an area of high harbor porpoise abundance. Additional work will be needed to determine inshore/offshore gradients.

As on the previous cruise, observers noted the direction of movement of the marine mammals that they sighted at the time of sighting. As before, the predominant direction of harbor porpoise movement was opposite the direction of the vessel. This apparent reaction to the vessel was not typically accompanied by rapid surfacing movements or splashing, which were only observed in a few individuals that surfaced immediately in front of the ship and within 100 meters. Active avoidance of the ship is thus not likely to be a major problem in ship surveys, but more passive avoidance (such as increased dive times) may be very significant.

Expendable bathythermograph (XBT) probes were launched to determine subsurface temperature structure. Positions of these launches are given in Table 5.

RECOMMENDATIONS FOR FUTURE RESEARCH:

In considering results of this cruise and the previous harbor porpoise survey, several major gaps still exist in our understanding of harbor porpoise distribution on the west coast of the United States. In order to obtain accurate population estimates, some of these gaps must be filled. These include:

1) The large scale seasonal movement of harbor porpoise may result in considerable mixing of local populations. In fact, local populations

may not exist and the entire north American coastline may be inhabited by a single stock. In order to estimate population size, the stock structure must be defined. A large scale tagging study would be valuable in establishing movement patterns. Shore stations might also be used to observe the predominant direction of movement of undisturbed animals during the suspected periods of movement.

2) Harbor porpoise appear to react to the presence of ships, which may bias estimates of harbor porpoise abundance. Unlike spotted dolphins which avoid ships by rapidly swimming away, avoidance by harbor porpoise is likely to be more passive. Harbor porpoise may simply remain submerged until a ship passes over them. Here again, shore stations might be a valuable tool for study. Using theodolite tracking methods, a shore station might be able to monitor the movement and breathing patterns of several harbor porpoise groups before, during, and after the passage of a large vessel.

3) Despite efforts made on this cruise, very little is known about the offshore gradient in the distribution of harbor porpoise. This is a very large component to any population size calculation. It is necessary to repeat the sort of experiment described above in an area of relatively high harbor porpoise abundance. In order to develop a quantitative model of changing porpoise distribution with depth, it will probably be necessary to survey along a series of depth contours from 10 to perhaps 100 fathoms. This experiment could be incorporated into the scheduled aerial survey for harbor porpoise this year. Radio tags may also be useful for determining the mean distance from shore for harbor porpoise.

4) Logistic constraints limited us to using 3 observers during much of this cruise. Given current budget projections, future cruises may be similarly constrained. It would be, therefore, desirable to test the relative sighting efficiency of 3 and 5 observers. To be accurate, the test should occur in a high density area and both teams should survey the same area under similar sighting conditions. Plans for such a comparison on this cruise were thwarted by bad weather north of San Francisco.

DISPOSITION OF DATA

Marine mammal sighting forms and effort logs were given to Al Jackson (SWFC) for editing and entry into a data base. Data on sea surface temperature and salinity and one digitized XBT data cassette were retained by the cruise leader for future use.

Appendix 2AD. Cruise report for SWFSC Cruise 0910. (Continued)

Prepared by Jay Barlow Dated: 28 Feb '85
Jay Barlow
Chief Scientist

Approved by Izadore Barrett Dated: 3/4/85
Izadore Barrett
Director, SWFC

Distribution: see attached list.

Table 1. Average daily vessel speeds calculated from distance-made-good and transit times during straight segments of the cruise track.

Date	Vessel Speed
January 25	11.4 knots
26	11.2
27	10.6
28	10.5
29	-
30	8.7
31	10.7
February 1	10.4
2	10.6
3	10.9
4	10.6
5	9.3
6	10.3
7	10.9
8	9.0

Appendix 2AD. Cruise report for SWFSC Cruise 0910. (Continued)

Table 2. Time and location of cetacean sightings, excluding Phocoena and Eschrichtius. Sea state refers to the estimated Beaufort number at the time of the sighting. Group size is the median of the independent estimates by each observer who recorded group size.

DATE	TIME	SPECIES	LATITUDE	LONGITUDE	SEA STATE	EST. GROUP SIZE
1/25	0958	Megaptera novaeangliae	48° 04'N	124° 44'W	2	1
1/26	1508	Balaenoptera acutorostrata	44° 56'	124° 03'	1	1
2/2	1200	Phocoenoides dalli	36° 31'	121° 58'	4	2
2/3	1655	Delphinus delphis	35° 54'	121° 29'	4	175
2/4	1040	Phocoenoides dalli	37° 31'	122° 51'	2	2
2/5	1402	Phocoenoides dalli	37° 04'	122° 23'	1	4
	1510	Orcinus orca	36° 56'	121° 14'	1	8
2/6	1328	Orcinus orca	36° 37'	121° 57'	1	5
2/8	0736	Grampus griseus/ Tursiops truncatus	33° 26'	118° 36'	2	25
	0834	Delphinus delphis	33° 25'	118° 33'	1	55
	0951	Tursiops truncatus/ Eschrichtius robustus	33° 17'	118° 25'	1	11
	1002	Globicephala macrorhynchus	33° 18'	118° 25'	2	14
	1102	Delphinus delphis	33° 17'	118° 22'	2	70
	1113	Tursiops truncatus	33° 17'	118° 22'	2	2
	1220	unidentified dolphin	33° 22'	118° 17'	1	1
	1244	unidentified dolphin	33° 24'	118° 19'	1	1
	1342	unidentified dolphin	33° 29'	118° 30'	2	2
	1509	Delphinus delphis	33° 25'	118° 38'	2	50
	1607	Grampus griseus/ Tursiops truncatus	33° 18'	118° 39'	2	23

Appendix 2AD. Cruise report for SWFSC Cruise 0910. (Continued)

Table 3. Number of cetacean sightings stratified by sea state at the time of the sighting. Unidentified whales and gray whales (E. robustus) were not tallied by sea state.

	Beaufort Sea State						
Species	0	1	2	3	4	5	Total
Delphinus delphis		1	2		1		4
Grampus griseus			2				2
Tursiops truncatus			3				3
Orcinus orca		2					2
Globicephala macrorhynchus			1				1
Balaenoptera acutorostrata		1					1
Megaptera novaeangliae			1				1
Phocoenoides dalli		1	1		1		3
Phocoena phocoena	14	53	13	6	2	1	89
unidentified dolphin		2	1				3
unidentified whale							63
Eschrichtius robustus							321

Table 4. Percentage of *Phocoena* sightings made at various sea states, and percentage of searching time spent at those sea states from 25 January to 07 February.

Beaufort Sea state	Percentage of *Phocoena* sightings	Percentage of Searching effort
0	15.7 %	2.0 %
1	59.6	36.7
2	14.6	30.9
3	6.7	18.6
4	2.2	9.0
5	1.1	2.7
TOTAL	99.9 %	99.9 %

Table 5. Positions at which XBT probes were launched.

Date	Time	Latitude	Longitude
25 January	1210	47° 44' N	124° 30' W
26	1409	45° 10'	124° 00'
27	1605	41° 55'	124° 15'
28	1308	39° 12'	123° 48'
30	1212	37° 58'	122° 49'
1 February	1206	37° 36'	122° 32'
3	1719	35° 52'	121° 29'
4	1241	37° 19'	122° 38'
7	1231	35° 03'	120° 50'
8	1700	33° 26'	118° 38'

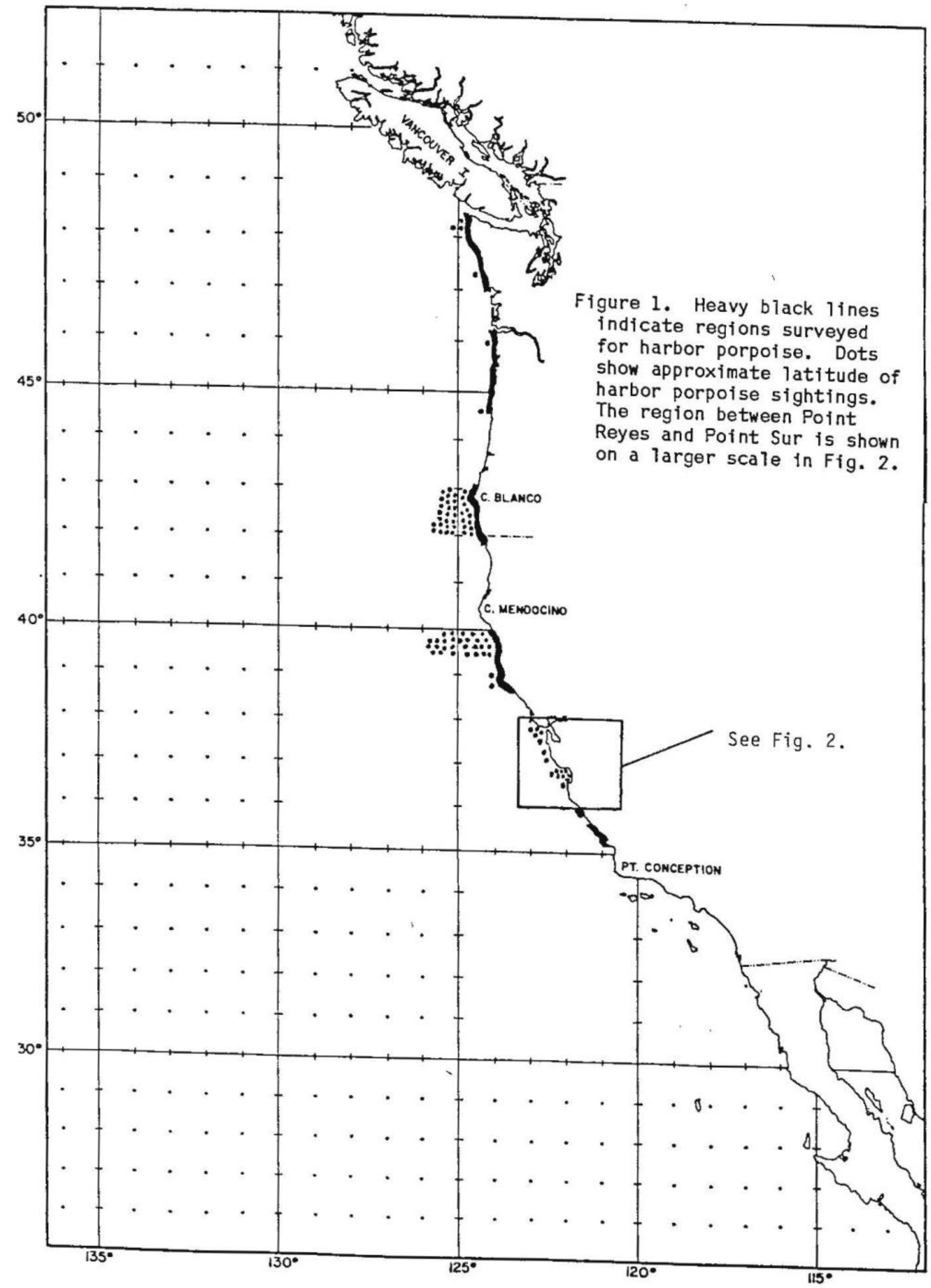

Figure 1. Heavy black lines indicate regions surveyed for harbor porpoise. Dots show approximate latitude of harbor porpoise sightings. The region between Point Reyes and Point Sur is shown on a larger scale in Fig. 2.

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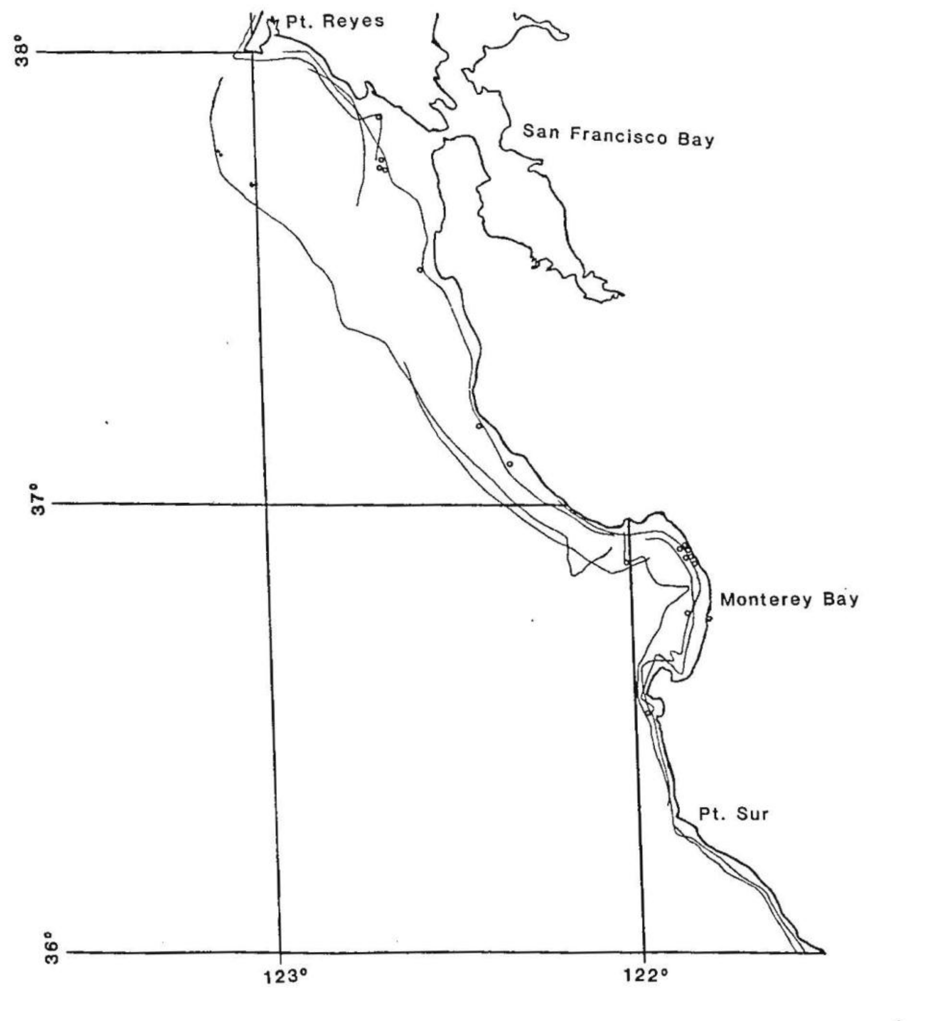
Figure 2. Survey tracks and harbor porpoise sightings between Point Reyes and Point Sur in California. Outer lines are surveys along 50 fathom isobath. Open circles show position of harbor porpoise sightings.



Appendix 2AD. Cruise report for SWFSC Cruise 0910. (Continued)

DISTRIBUTION for Cruise Number MA-85-01:

F/SWC:
I. Barrett
V. Breda
J. Carr
L. Farrar (10)
D. Losey
B. Remington
J. Thrailkill
L. Vlymen
R. Whyte
J. Barlow (10)
F. Begley (20)
A. Coan
D. DeMaster
S. Hawes
A. Hohn
R. Lasker
W. Perrin
W. Parks
G. Sakagawa
P. Smith

F/SWC2:
R. Shomura

F/SWC3:
N. Abramson

F/NWC3:
M. Nerini
B. Taylor
R. DeLong

F/SWC4:
A. Bakun

IATTC:
J. Joseph

SIO:
J. McGowan, A-028
W. Nierenberg, A-010
R. Cowan, A-008

F/S:
J. Angelovic

F/M4:
R. Roe

F/SWR:
C. Fullerton
G. Smith

F/SWR34:
N. Mendes

F/SER:
J. Brawner

F/NEC2:
R. Marak

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Mr. Jeff Jones, President
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Dr. Richard Ford
Center for Marine Studies
San Diego State University
San Diego, California 92182

San Diego Tribune
Attn: Mr. Vern Griffin
P.O. Box 191
San Diego, California 92112

COMPMR
Naval Air Station
Pt. Magu, California 93042
Attn: Code 3200

Mr. Robert Vent
NOSC
Code 6352
San Diego, California 92152

Instituto Nacional de Pesca
Attn: J. Carranza
Alvaro Obregon 269, Piso 10
Mexico 7, D.F

Mr. Craig Fusaro
Liaison Office
418 Chapala, Suite 1
Santa Barbara, California 93101

Mr. Bob Fletcher, Deputy Director
Calif. Dept. of Fish & Game
1416 Ninth Street
Sacramento, CA 95814

Appendix 2AE. Cruise report for SWFSC Cruise 0942.

N. Losey

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southwest Fisheries Center
P.O. Box 271
La Jolla, CA 92038

October 3, 1985   F/SWC1

CRUISE REPORT

VESSEL:
NOAA R/V David Starr Jordan, Cruise No. DS-85-09
Southwest Fisheries Center, Marine Mammal Cruise No. 942

DATES:
3 to 17 September 1985

PROJECT:
Harbor Porpoise Survey

ITINERARY:

03 September 1985,	1030	Departed San Diego, Nimitz Marine Facility
05 September	0600	Picked up observer, Santa Cruz Pier, CA
11 September	1900	Took refuge from storm, Astoria, OR and dropped off observer
13 September	0800	Departed Astoria, OR with new observer
17 September	1700	Arrived San Diego, Nimitz Marine Facility

SCIENTIFIC PERSONNEL:

Ship Survey

1. Jay Barlow	SWFC	(chief scientist)
2. Stephanie Sexton	SWFC	
3. Francis Mann	SWFC	
4. Peter Boveng	Montana State University	
5. Sharon Bragg	Sonoma State College	
6. Betty Goetz	Northwest and Alaska Fisheries Center, REFM	
7. Susan Kruse	University of California, Santa Cruz	
8. Michael Newcomer	Moss Landing Marine Lab	
9. Alejandro Robles	Escuela de Ciencias Maritimas, Guaymas, Mexico	
10. Barry Troutman	Washington State Department of Wildlife	
11. Barbara Taylor	Northwest and Alaska Fisheries Center, NMML	

Shore Survey

11. Barbara Taylor	NMML	(coordinator)
12. Mike Herter	NMML	
13. Tom Loughlin	NMML	
14. Dick Merrick	NMML	
15. Rich Rowlett	NMML	
16. Dave Rugh	NMML	
17. Bill Yerman	NMML	

OBJECTIVES:

This report describes the survey procedures and preliminary results from the third Southwest Fisheries Center (SWFC) survey for harbor porpoise (*Phocoena phocoena*). The purpose was to survey harbor porpoise abundance along a coastal strip from Cape Flattery in northern Washington to Point Conception in central California. The primary objectives were: 1) to gather additional data for harbor porpoise population estimation and to gather information on the offshore distribution of harbor porpoise; 2) to study vessel avoidance by harbor porpoise in Oregon, working with a shore-based survey team from the National Marine Mammal Laboratory, Seattle; and 3) to study the relative effectiveness of aerial and ship-based survey methods for harbor porpoise. Results of the coordinated aerial survey will be reported separately. Results presented here include the ship-based and shore-based surveys only.

METHODS:

Ship Surveys

During the harbor porpoise survey, the *Jordan* followed a coastal route from Point Conception, CA to the Columbia River (Fig. 1). The coastal strip along the state of Washington was missed due to gale-force winds. During daylight hours, the ship typically followed the 10-fathom isobath (with a minimum distance of approximately 3/4 mile from the coast and 1/2 mile from any navigation hazards). In three areas (Fort Bragg to Cape Vizcaino, CA; Cape Blanco to Coquille Pt., OR; and Cape Lookout to Tillamook Head, OR) the 30-, 50-, and 100-fathom isobaths were also surveyed to determine the offshore distribution of harbor porpoise. At night the ship typically steamed to the starting point of the next day's survey. The ship's speed was maintained at 10.0 to 11.5 knots. The ship was stopped or was turned from the cruise track only when additional time was required to make species identifications or group size estimates.

Surveys for harbor porpoise consisted of a team of 5 observers searching with Fujinon 7x50 hand-held binoculars and by unaided eye. All observers were stationed on the flying bridge. The two observers on the far right and left searched with 7x binoculars from straight ahead to 90° on their side of the vessel. The inside observers on the right and left searched with 7x binoculars from straight ahead to 45° on their side of the vessel. The middle observer was the data recorder and searched with unaided eye for porpoise that surfaced close to the vessel. Personnel in each position were changed every 30 minutes to avoid fatigue. Fujinon 25x150 binoculars were used to verify identification on distant sightings. Ocular reticles in the 7x and 25x binoculars were used to estimate distance to a sighted animal. Reticle scales were calibrated on this cruise using a navigational buoy as a target. The actual distance to the target was measured by radar. One observer using a 25x binocular and three observers using 7x binoculars made independent estimates of the reticle distance to the buoy.

Sightings of cetaceans other than harbor porpoise were recorded as being "off effort". In cetacean surveys by the SWFC, "effort" has been defined as two observers searching with 25x binoculars and a recorder "guarding the trackline". When searching for harbor porpoise, we only used 7x binoculars and were looking relatively close to the vessel for a very specific search image. Sighting efficiency for other species was much lower than when using standard searching methods, which is why other sightings were not recorded as "on effort". "Off effort" observations of marine mammals were also made during our transits of the Southern California Bight, using both 25x and 7x binoculars.

Typically, a harbor porpoise sighting referred to an association of 1-6 individuals which surfaced synchronously within a few meters of each other. Occasionally it was not possible to delineate all such groups in a high density area, and a sighting then referred to a loose assemblage of subgroups. During surveys, all observers were informed when a sighting was made, and the observers were free to discuss information pertaining to species identification. Individual estimates of species proportions and group size were kept confidential. Off-duty personnel were prevented from pointing out marine mammals to the on-duty observers, but they were allowed to make group size estimates once a sighting was made. Search effort was discontinued several times due to poor sighting conditions. In general, effort was terminated when visibility was reduced to less than 1 nautical mile due to fog or rain, or when the sea state was greater than a Beaufort 5.

Harbor porpoise sightings and searching effort information was coded on the "Research Vessel Harbor Porpoise Sighting and Effort Record". All other cetacean sightings were recorded on the "Research Ship Marine Mammal Sighting Record". The first page of the latter was filled out by the recorder after a sighting, and a continuation page was filled out by each observer who saw the animals. Ship's position and speed were taken from the Omega navigation system. Sea surface temperature was measured using a continuous flow-through thermo-salinograph. Position, speed and temperature were printed automatically when the recorder made a request to the duty officer, and these data were transferred to data coding forms at the end of the day. In order to allow future data analysis by line-transect methods, sighting angles and distances were estimated for each group of animals. When 25x binoculars were used, angles were estimated from a graduated collar. Radial distances were estimated using ocular reticles mounted in the 7x and 25x binoculars.

Shore Surveys

The primary objective of the shore-based surveys was to detect any changes in porpoise ventilation and movement patterns in the presence of the survey vessel which would affect porpoise sightability. Observers were stationed at four rocky headlands in northern Oregon (Tillamook Head, Neahkahnie Mountain, Cape Meares, and Cape Lookout) from 7-11 September 1985. Observers were equipped with Fujinon 7x50 binocular compasses with reticles. Again a sighting consisted of a close surfacing association. Ventilation data were collected for each sighting and included time, number of animals at the surface, heading of animals during surfacing, direction of travel between series of surfacings, compass bearing to the animals, and reticle distance. A surfacing series was considered over when the time between surfacings exceeded 30 seconds. The time between surfacing series was termed down time. A sample from a group of porpoise was considered complete if it contained three consecutive down times. Data were typically recorded by one observer calling out the number of animals at the surface, heading, bearing and reticle distance either to a designated data recorder or into a tape recorder. Several ventilations were recorded while using 20x120 binoculars, which had no reticles. A Nikon NT-2 theodolite was used to locate the site position, determine the elevation, and calibrate the reticles.

Systematic surveys were conducted at 0900, 1330, and 1800 each day to determine porpoise distribution. At two sites, two observers equipped with 7x binoculars would systematically search their field of view, spending 3 minutes viewing each 6^{o} segment. If porpoise were spotted, the observer with the sighting began recording ventilation data onto tape while the second observer continued the survey. Number of animals, bearing, and reticle distance were recorded for each porpoise sighting. At the third site, Tillamook Head, surveys were completed with the 7x binoculars covering the area out to 1.25 miles while the 20x binoculars covered from 1.25 to 2.5 miles.

RESULTS:

Ship Surveys

The location of harbor porpoise sightings are shown in Fig. 1. The location of all other cetacean sightings are given in Table 1. The number of sightings of each species, stratified by sea state at the time of the sighting, is given in Table 2. As on the previous surveys, harbor porpoise were sighted more frequently in calm seas. When the percentage of sightings at each sea state is compared to the percentage of sighting effort spent at those sea states (Table 3), sighting efficiency for harbor porpoise appears to decrease rapidly as sighting conditions worsen. As in previous harbor porpoise cruises, the predominant direction of porpoise movement was opposite the direction of travel for the vessel.

A major objective of the cruise was to determine the inshore/offshore gradient in harbor porpoise distributions. Prior to the cruise, two areas were selected for this study, based on previous records of high harbor porpoise abundance: south of Cape Mendocino in California and south of the Columbia River in Oregon. In these areas, transects were run along the 10-, 30-, 50-, and 100-fathom isobaths. During this cruise, the California site was found to have a low abundance of harbor porpoise, and thus a third site was chosen in southern Oregon. Transects at all depths were repeated in the morning and afternoon to control for possible offshore movements of harbor porpoise in afternoons. The results at these three study sites are shown in Table 4. These results indicate that harbor porpoise abundance was relatively high from shore to the 30-fathom line, it dropped slightly by 50 fathoms, and none were seen along the 100-fathom isobath. Some variation was noted between sites, with harbor porpoise in northern Oregon showing the shallowest distribution. In this location, however, results may have been confounded by rougher sea states during the offshore transects. We saw no evidence that harbor porpoise were moving further offshore during the afternoons.

Results of the binocular reticle calibration are shown in Fig. 2. Best least-square fits to these data were obtained using the equation shown in Fig. 2 by fixing the distance above the water (a=0.00576 N.M.) and obtaining the best value for "b". The resulting curves fit these data adequately, but not perfectly. Also, the parameter values that had been previously used for the 25x binoculars (dot-dash line in Fig. 2) appear to have a systematic error. Distances were converted from reticles to linear distance using values of b=0.395 for 7x binoculars and b=0.0823 for 25x binoculars, with the knowledge that refinements in calibration may require that distances be recalculated at a later date. Use of reticles on 7x binoculars gave a considerable improvement in accuracy over distance estimates made by naked eye.

Expendable bathythermograph (XBT) probes were launched to determine subsurface temperature structure. Positions of these launches are given in Table 5.

Shore Surveys

Prior to arrival of the vessel (9/7-9/9) sighting conditions were good (Beauf. 0-2) and 9 complete and 2 partial ventilation records were obtained (Table 6). Percent time at the surface was calculated two ways: 1) the actual time porpoise were visible above the water surface, and 2) the amount of time spent in surfacing series. These surfacing times (Table 6) showed high variability between groups.

When the *Jordan* was present (9/10-9/11), it conducted inshore/offshore studies in the vicinity of the shore stations. On 9/10 land observations were made from Cape Meares, Neahkahnie Mountain, and Tillamook Head under poor sighting conditions (Beauf. 3-5 with intermittent heavy rains). One animal was seen off Cape Meares but observers were unable to follow the animal. A concerted effort of all six observers at two sites on Tillamook Head produced no harbor porpoise sightings in the presence of the vessel. On 9/11 winds increased to 15-20 knots; no porpoise were seen from land or ship. The experiment was terminated due to inclement weather.

Daily surveys showed that porpoise were routinely seen only off Tillamook head (Table 7). Mean group size was 2.28 (n=29, s=1.19), where a group is defined as porpoise surfacing within three meters of one another with synchronous surfacing series. No patterns of movement could be detected. Porpoise headings were: 22 headed north, 20 south, 6 northwest, 3 southwest, 2 southeast, 1 east, 1 west, and 10 milling.

RECOMMENDATIONS FOR FUTURE RESEARCH:

Considerable progress was made in understanding the offshore distribution of harbor porpoise during this survey. Although local patterns seem to change, the general pattern of north/south distribution seem well established from this and the previous two cruises. From the viewpoint of stock assessment, one of the principle remaining problems is harbor porpoise avoidance of research vessels. The porpoise seen from research vessels are primarily traveling opposite the direction of the ship; however, the direction of movement of animals observed from the shore is uniformly distributed between north and south. Porpoise must be reacting to the vessel before they are seen. During this cruise, off-duty personnel noted several occurrences of undetected harbor porpoise surfacing within 100 meters of the vessel. Although no formal records were kept, these observations represented a very small percentage of the total sightings (less than 5%). If this number avoid detection by the observers and if porpoise are reacting to the vessel before they are seen, it is possible that a greater number avoid detection entirely. Therefore, the question is not whether porpoise can avoid detection, but rather what fraction of track-line animals do avoid detection.

The use of shore-based observers to study the effects of vessel avoidance proved impractical due to low numbers and the unpredictable, patchy distribution of animals. Although small-scale distribution patterns have not been examined, it appeared that porpoise occurred more frequently off sandy beaches. Since shore-surveys are largely limited to high, rocky headlands, this would also limit their practicality for vessel avoidance experiments. It was clear from our experience during this cruise that shore-based observations might never yield the needed information.

Three methods could be useful in resolving the question of ship avoidance. 1) An aerial observation platform, such as a small helicopter, would be much better than shore stations for studying vessel avoidance. An experiment (similar to Roger Hewett's) could be conducted using a helicopter to locate porpoise on the trackline several miles ahead of the ship. Once a group was sighted, the position of the group could be monitored by tracking the helicopter on the ship's radar. Observations on ventilation frequencies and avoidance behavior could be made from the helicopter. 2) Avoidance and the percentage of missed animals could be studied in conjunction with a porpoise radio-tagging program at the Univ. of Calif., Santa Cruz. Radio tracking equipment on the ship could be used monitor radio-tagged individuals as they passed in the vicinity of the vessel. 3) Additional observers could be added to the survey team to search astern for any porpoise that avoided detection by the fore-looking observers. Although difficult to interpret, these data might establish a minimal estimate of the fraction of porpoise that are missed.

Given that off-duty personnel noted several porpoise surface near the vessel and yet go undetected, it is clear that observer efficiency should be improved, if possible. Because these observations occurred primarily when the recorder was getting data from another of the observers, this operation may be a weak link in the system. It is therefore recommended that a sixth observer be added whose sole duty would be to watch area in the immediate vicinity of the vessel.

Finally, additional work may be necessary in calibrating reticles for both the 7x and 25x binoculars. The equation that has been used in the past (Fig. 2) does not consider such factors as the bending of light due to the temperature gradient at the sea/air boundary or the effect of sea state. This may be a particular problem if binoculars are calibrated in southern California at Beaufort 1, and these calibrations are subsequently used in northern Washington or in the tropics.

Appendix 2AE. Cruise report for SWFSC Cruise 0942. (Continued)

DISPOSITION OF DATA

Marine mammal sighting forms and effort logs were given to the SWFC Data Management Task for editing and entry into a data base. Data on sea surface temperature and salinity and XBT data were retained by the chief scientist for future use. Data gathered by shore-based survey teams were retained by Barbara Taylor, National Marine Mammal Lab, Seattle, WA.

Prepared by Jay Barlow, Chief Scientist
Barbara Taylor, Shore Survey Coordinator
Stephanie Sexton

Approved by Jay Barlow Date: 10-4-85
Jay Barlow
Chief Scientist

Approved by Izadore Barrett Date 10/7/85
Izadore Barrett
Director, SWFC

Distribution: see attached list.

Appendix 2AE. Cruise report for SWFSC Cruise 0942. (Continued)

Table 1. Time and location of cetacean sightings, excluding Phocoena. Sea state refers to the estimated Beaufort number at the time of the sighting. Group size is the median of the independent estimates by each observer who recorded group size.

DATE	TIME	SPECIES	LATITUDE	LONGITUDE	SEA STATE	EST. GROUP SIZE
9/03	1344	Balaenoptera physalus	32° 53'N	117° 41'W	4	1
	1350	unidentified whale	32° 53'	117° 43'	4	1
	1650	unidentified whale	33° 08'	118° 15'	4	1
9/04	0643	unidentified dolphin	34° 28'	120° 29'	2	1
	0717	Lagenorhynchus obliquidens	34° 33'	120° 34'	1	12
	1248	Orcinus orca	35° 15'	120° 55'	1	5
	1440	Balaenoptera acutorostrata	35° 30'	121° 05'	1	1
9/05	0906	unidentified whale	37° 07'	122° 18'	2	1
	1650	Megaptera novaeangliae	38° 05'	122° 59'	2	1
	1844	Balaenoptera musculus	38° 18'	123° 05'	2	8
9/06	0749	Phocoenoides dalli	39° 38'	123° 49'	1	8
	0752	Phocoenoides dalli	39° 39'	123° 49'	1	4
	0851	Phocoenoides dalli	39° 32'	123° 51'	1	2
	0903	Phocoenoides dalli	39° 29'	123° 51'	1	3
	1015	Phocoenoides dalli	39° 29'	123° 59'	2	4
	1103	Phocoenoides dalli	39° 38'	123° 58'	2	3
	1859	Megaptera novaeangliae	39° 42'	123° 52'	2	2
9/07	0842	Balaenoptera acutorostrata	41° 12'	124° 10'	2	1
	0917	unidentified whale	41° 17'	124° 08'	1	1
	0929	Balaenoptera acutorostrata	41° 19'	124° 07'	1	1
	1318	unidentified porpoise	41° 51'	124° 23'	2	2
	1335	unidentified whale	41° 53'	124° 25'	2	1
	1841	Eschrichtius robustus	42° 45'	124° 32'	2	2
	1859	Eschrichtius robustus	42° 49'	124° 33'	2	2
9/08	0712	Eschrichtius robustus	43° 04'	124° 27'	2	1
	0858	Megaptera novaeangliae	42° 53'	124° 37'	2	2
	1016	Balaenoptera acutorostrata	43° 02'	124° 33'	1	1
	1059	Balaenoptera acutorostrata	43° 07'	124° 37'	1	1
	1113	unidentified whale	43° 07'	124° 40'	1	1
	1123	Orcinus orca	43° 06'	124° 42'	2	1
	1141	unidentified dolphin	43° 03'	124° 44'	2	4
	1214	Phocoenoides dalli	43° 04'	124° 51'	3	5
	1317	Phocoenoides dalli	42° 59'	124° 51'	2	5
	1539	Megaptera novaeangliae	43° 00'	124° 34'	3	2
	1548	Megaptera novaeangliae	42° 58'	124° 35'	3	3
	1734	Eschrichtius robustus	43° 05'	124° 28'	2	1
	1846	Balaenoptera acutorostrata	43° 10'	124° 26'	2	1

Appendix 2AE. Cruise report for SWFSC Cruise 0942. (Continued)

9/09	0700	Balaenoptera acutorostrata	43° 13'	144° 25'	2	1
	0835	unidentified whale	43° 28'	124° 17'	1	1
	0844	Megaptera novaeangliae	43° 29'	124° 17'	1	3
	0912	unidentified whale	43° 34'	124° 15'	1	1
	1540	Eschrichtius robustus	44° 39'	124° 06'	1	1
	1609	Eschrichtius robustus	44° 44'	124° 06'	2	1
	1617	Eschrichtius robustus	44° 45'	124° 05'	2	1
	1630	Eschrichtius robustus	44° 48'	124° 05'	2	1
9/11	0812	Phocoenoides dalli	45° 46'	124° 35'	4	3
	1108	Phocoenoides dalli	45° 40'	124° 07'	3	2
	1640	Balaenoptera acutorostrata	45° 53'	124° 06'	5	1
9/13	1048	Balaenoptera acutorostrata	46° 03'	124° 04'	5	1
9/14	0802	Balaenoptera musculus	42° 51'	124° 39'	5	1
9/15	0710	unidentified whale	39° 22'	123° 49'	2	2
	0853	Phocoenoides dalli	39° 06'	123° 45'	2	7
9/16	1015	Phocoenoides dalli	36° 33'	121° 59'	2	6
	1243	Orcinus orca	36° 09'	121° 41'	3	2
	1623	unidentified porpoise	35° 37'	121° 13'	2	4
	1649	unidentified dolphin	35° 34'	121° 08'	2	3
	1739	Balaenoptera acutorostrata	35° 44'	121° 20'	2	1
9/17	0626	Delphinus delphis	33° 37'	119° 16'	3	25
	0658	Delphinus delphis	33° 35'	119° 11'	3	103
	0754	unidentified whale	33° 30'	119° 00'	1	1
	0758	Tursiops truncatus	33° 30'	118° 59'	1	5
	0928	Delphinus delphis	33° 21'	118° 38'	3	10
	0938	Delphinus delphis	33° 21'	118° 38'	3	3
	0941	Delphinus delphis	33° 21'	118° 37'	3	25
	0949	Delphinus delphis	33° 20'	118° 36'	3	50
	0955	Delphinus delphis	33° 19'	118° 34'	3	10
	1006	Delphinus delphis	33° 18'	118° 32'	3	350
	1113	Tursiops truncatus	33° 11'	118° 17'	3	9
	1127	unidentified dolphin	33° 08'	118° 12'	3	1
	1137	unidentified dolphin	33° 08'	118° 12'	3	4
	1223	Tursiops truncatus	33° 05'	118° 03'	3	6
	1557	Lagenorhynchus obliquidens	32° 41'	117° 18'	3	3

Table 2. Number of cetacean sightings stratified by sea state at the time of the sighting.

Species	Beaufort Sea State 1	2	3	4	5	Total
Delphinus delphis			8			8
Tursiops truncatus	2		1			3
Lagenorhynchus obliquidens	1		1			2
Orcinus orca	1	1	1			3
Balaenoptera acutorostrata	4	4			2	10
Balaenoptera musculus		1			1	2
Balaenoptera physalus				1		1
Megaptera novaeangliae	1	3	2			6
Phocoenoides dalli	4	5	2	1		12
Phocoena phocoena	127	137	5	3	3	275
unidentified dolphin		2	2	1		5
unidentified porpoise		2				2
unidentified whale	5	3		2		10
Eschrichtius robustus	1	7				8
Total						336

Table 3. Percentage of *Phocoena* sightings made at various sea states, and percentage of searching time spent at those sea states. The relative number of sightings per effort was normalized to 1.0 at Beaufort 1.

Beaufort Sea State	Percentage of *Phocoena* Sightings	Percentage of Searching Effort	Relative Sightings per Effort
1	46.2 %	31.5 %	1.00
2	49.8	45.6	0.74
3	1.8	12.7	0.10
4	1.1	8.0	0.09
5	1.1	1.8	0.42
6	-	0.4	0.00
Total	100.0	100.0	

Table 4. Offshore distribution of harbor porpoise. Number of sightings are given, stratified by their position relative to the vessel and the shore, for transects at 10-, 30-, 50-, and 100- fathoms at three different locations. The number of miles searched and the sighting rate in porpoise groups per mile are also given. Mean beaufort was calculated as the average of the sea states experienced during the transects. Searching effort and sightings as Beaufort sea states 4 and higher were not included.

	Number of Sightings					
	Inshore	Trackline	Offshore	Nautical Miles	Sightings per Mile	Mean Beaufort
Fort Bragg, CA						
10-fathoms	1	0	1	21.6	0.093	1.45
30-fathoms	2	0	0	22.7	0.088	1.66
50-fathoms	1	0	0	19.4	0.052	1.30
100-fathoms	0	0	0	14.1	0.0	2.00
Coquille Pt., OR						
10-fathoms	3	3	4	23.5	0.426	1.85
30-fathoms	9	4	5	28.3	0.636	2.40
50-fathoms	2	0	2	27.4	0.146	2.00
100-fathoms	0	0	0	34.9	0.0	2.65
Tillamook Head, OR						
10-fathoms	13	3	13	31.5	0.921	2.13
30-fathoms	1	1	4	28.5	0.211	2.03
50-fathoms	0	0	0	9.0	0.0	3.00
100-fathoms	0	0	0	3.6	0.0	3.00

Table 5. Positions at which XBT probes were launched.

Date	Time	Latitude	Longitude
9/04	1929	35° 12' N	120° 53' W
9/05	1933	37° 38'	122° 32'
9/06	1538	39° 35'	123° 50'
9/07	1529	41° 10'	124° 12'
9/08	1559	42° 52'	124° 36'
9/08	2146	43° 06'	124° 37'
9/09	2044	44° 18'	124° 02'
9/10	1749	45° 53'	123° 59'
9/11	1518	45° 46'	124° 33'
9/13	1756	46° 04'	124° 04'
9/14	1755	42° 26'	124° 33'
9/14	2226	41° 46'	124° 16'
9/15	1755	38° 48'	123° 43'
9/16	1754	36° 25'	121° 58'
9/17	1740	33° 15'	118° 25'

Table 6. Summary of harbor porpoise ventilation data gathered from shore stations. Down times are given as the three (or in some cases, two) time periods between consecutive surfacing series for individual groups of animals. Mean time between surfacings refers to the average time between breaths within a surfacing series. Time at the surface only includes times when some portion of the animals is above the surface. Time in surfacing series includes the time between first and last breaths within a surfacing series.

Number of Animals	Down Times (min.) 1st	2nd	3rd	Mean Time Between Surfacings (sec.) n	mean	s.d.	% Time at Surf.	% Time in Surf. Series
2	1.33	1.60	5.80	34	3.56	3.97	4	12
2	1.02	2.22		14	6.29	6.53	5	28
2	0.73	3.58	3.92	18	4.17	2.38	3	12
2	2.53	0.68	0.92	28	7.97	7.55	3	23
4	1.12	1.23	2.90	24	2.71	2.16	6	11
4	2.65	2.38		24	3.67	4.40	4	11
5	1.03	1.25	2.13	29	6.28	5.66	9	39
5	1.95	0.48	0.48	21	3.48	2.84	8	20
5	0.83	1.15	1.17	75	4.17	4.97	11	42
5	0.57	1.18	2.22	62	5.60	5.25	11	45
10	0.85	1.50	0.85	167	4.07	4.54	7	32
Mean	1.77 (n = 31)			4.72 (n = 11)			6.45	25.00
s.d.	1.20			1.59			2.98	13.05

Appendix 2AE. Cruise report for SWFSC Cruise 0942. (Continued)

Table 7. Times and numbers of harbor porpoise sighted during shore surveys at four locations in northern Oregon.

Location	Date	Time	Number Porpoise
Tillamook Head	9/7	0900	2
		1118	27
		1435	4
		1800	14
	9/8	0925	0
		1330	0
		1800	0
	9/9	0925	2
		1325	8
		1800	20
	9/10	1018	0
		1120	0
		1630	0
	9/11	0930	0
		1220	0
		1330	0
Cape Meares	9/7	0928	1
		1330	0
		1800	0
	9/10	0754	1
Cape Lookout	9/7	0900	0
	9/8	1515	3
	9/11	1104	0
Neahkahnie Mountain	9/7	1420	2
	9/8	0900	0
		1330	2
		1800	0
	9/9	0900	0
		1330	0
	9/10	0900	0
	9/11	0900	0

Appendix 2AE. Cruise report for SWFSC Cruise 0942. (Continued)

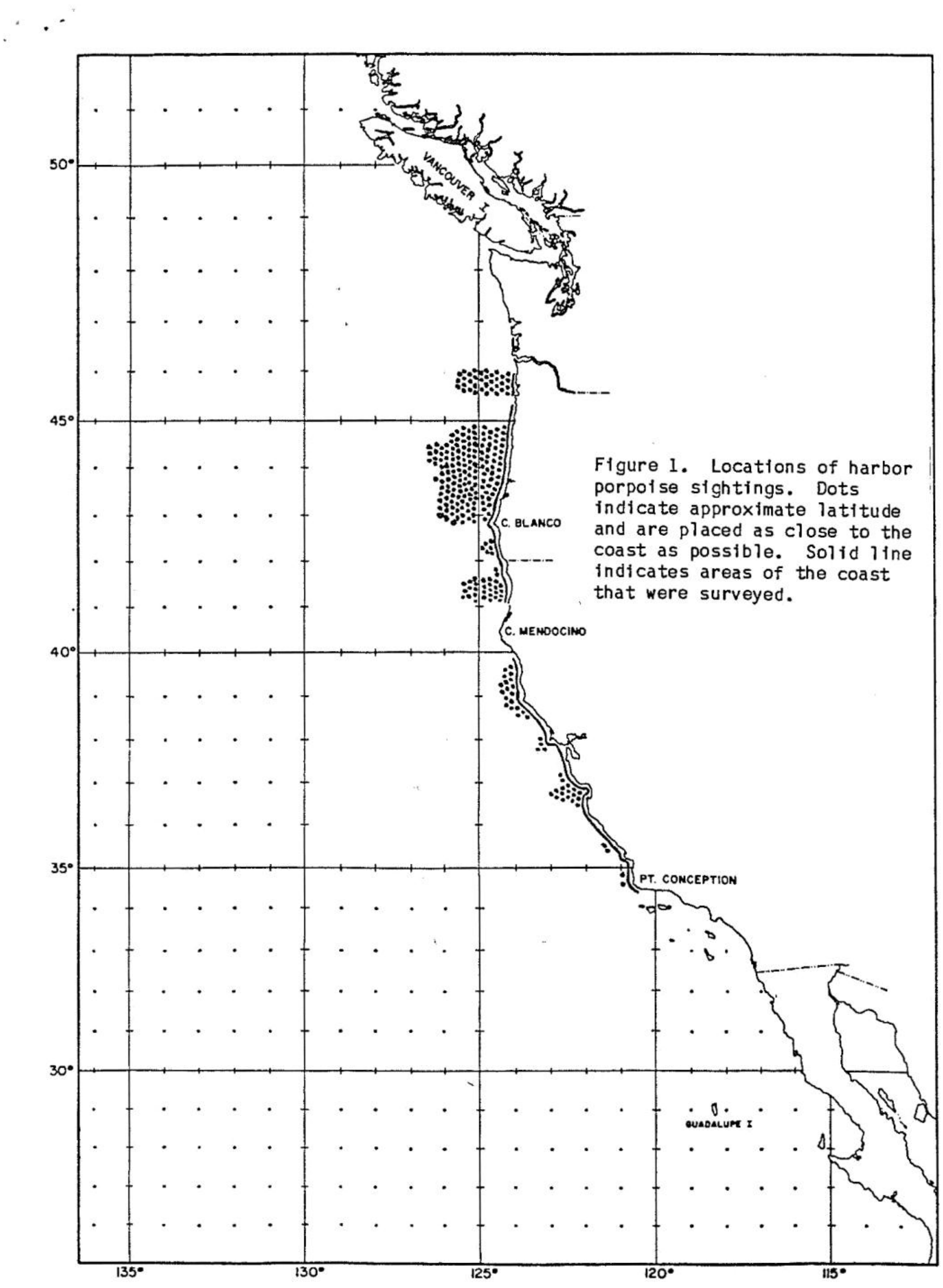

Figure 1. Locations of harbor porpoise sightings. Dots indicate approximate latitude and are placed as close to the coast as possible. Solid line indicates areas of the coast that were surveyed.

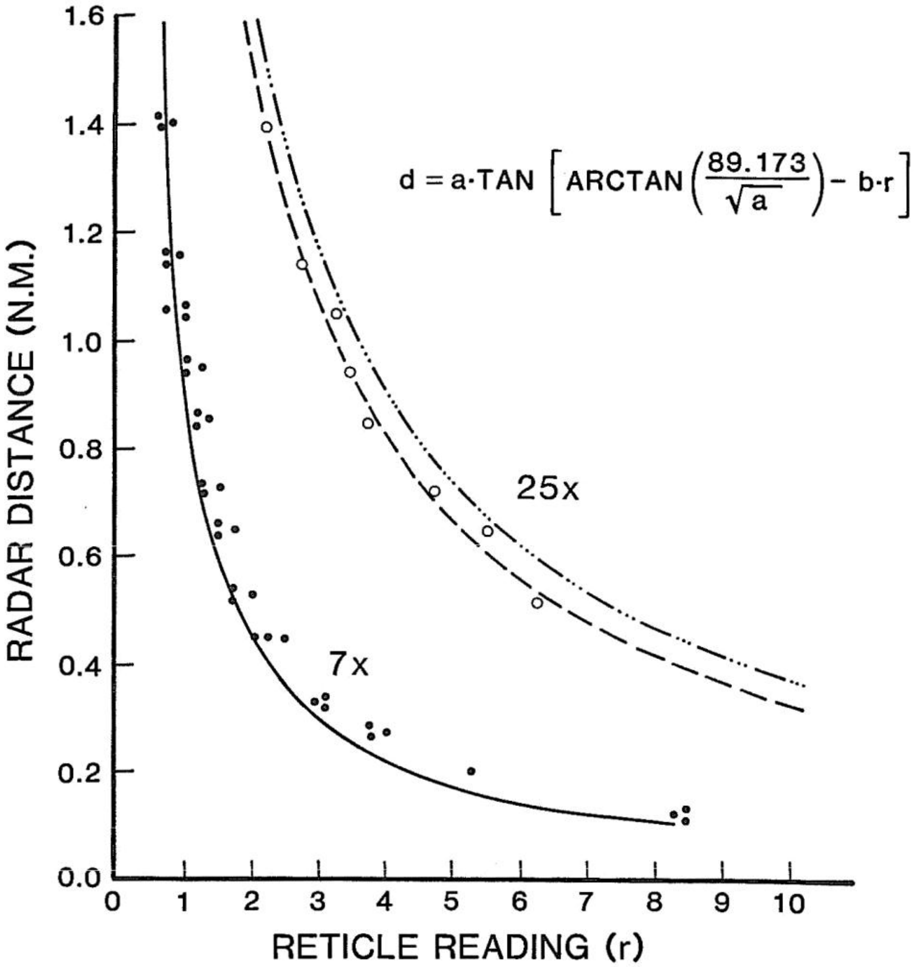

Figure 2. Calibration data for reticle oculars in 7x (solid circles) and 25x (open circles) binoculars. Least-squares fits were obtained using the above equation with the distance above water, "a", equal to 0.00576 N.M. Best fits were obtained with b=0.395 (7x binoculars, solid line) and b=0.0930 (25x binoculars, dashed line). The previously-used calibration for 25x binoculars (dot-dash line, b=0.0823) is included for comparison.

Appendix 2AF. Cruise report for SWFSC Cruise 0970.

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June 9, 1986 F/SWC1

CRUISE REPORT

VESSEL: R/V David Starr Jordan, Cruise 86-06 (201)
(and chartered Hughes-500D helicopter)

CRUISE DATES: Harbor porpoise survey: April 24 to May 5, 1986
Dover sole collections: May 2-5, 1986

ITINERARY:			
	24 April 1986,	0900	Departed Sausalito, CA
	02 May	1800	Picked up trawl crew, Santa Cruz, CA
	05 May	1500	Arrived San Diego, Nimitz Marine Facility

PORPOISE SURVEY PERSONNEL:

1. Jay Barlow, NMFS (Chief Scientist)
2. Stephanie Sexton NMFS
3. Peter Boveng NMFS
4. Randy Rasmussen NMFS
5. Sallie Beavers, C.D.F.G.
6. Sara Heimlich-Boran, Moss Landing Marine Lab
7. Izzy Szczepaniak, Cal. Academy of Science
8. Marc Webber, Oceanic Society
9. Kate Wynne, Univ. Maine
10. Vince Dollarhide, Moss Landing Marine Lab

HELICOPTER OBSERVERS:

1. Chuck Oliver, NMFS (Leader)
2. Rennie Holt, NMFS
3. Barbara Taylor, NMFS, National Marine Mammal Lab

TRAWL PERSONNEL:

11. William Flerx, NMFS (Watch Leader)
12 Ron Dotson, NMFS
13. Eric Lynn, NMFS
14. Robert Snodgrass, SIO Aquarium

I. PORPOISE SURVEY

OBJECTIVES:

The principal objective of the harbor porpoise survey was to gather information that could be used to evaluate methods and interpret data gathered on previous coastal ship and aerial surveys. The ship survey was coordinated with aerial observers in a helicopter to determine changes in porpoise behavior in response to a survey vessel. Data were gathered on the ability of additional observers on the ship to detect groups of porpoise that were missed by the principal observers. Additional data were collected on the inshore/offshore distribution of harbor porpoise. Aerial observations from the helicopter were also used to investigate the proportion of time that porpoise are visible from an aerial platform.

METHODS

Ship Surveys

During the cruise, the Jordan was used to intensively survey two areas in California that were believed to have high porpoise densities based on previous cruises: Monterey Bay and in the vicinity of the Russian River. In those areas, surveys were conducted along transect lines defined by the 10-, 25- and 40-fathom isobaths. Surveys were also conducted along the 10- and 25-fathom isobaths between these two study areas and along the 10-fathom isobath between Monterey Bay and Point Conception. The ship's speed was maintained at 9.5-10.5 knots. The ship was diverted from the transect line when additional time was required to make species identifications or group size estimates. Occasionally, when working with the helicopter, the ship was also diverted from the transect line in order to pass closer to a group of porpoise being observed from the air.

Surveys for harbor porpoise were conducted using a team of 5 observers stationed on the flying bridge and searching with either Fujinon 7x50 hand-held binoculars or with unaided eyes. The two observers on the far right and left searched with 7x binoculars from straight ahead to 90° on their side of the vessel. The two inside observers on the right and left searched with 7x binoculars from straight ahead to 45° on their side of the vessel. The middle observer was the data recorder and searched without binoculars for porpoise that surfaced close to the vessel. When working with the helicopter, two additional observers read and recorded the radar bearing and distance to the helicopter, and the chief scientist coordinated activities of the ship and helicopter using an aerial VHF radio. All members of the observation team rested approximately 30 minutes every 2 hours while the helicopter re-fueled. When not working with the helicopter, a "monitor" team of 3 observers (in addition to the principal team of 5 observers) searched with unaided eyes from the pilot house deck. Each team of observers kept separate records of sightings, and neither was made aware of sightings made by the other team. Personnel in each of the observer positions moved to a new position every 30 minutes, with a rested observer entering the rotation. When both teams were searching, there were only two "rest" positions. During these periods, an additional 30 minute rest period was added for all observers every 2 hours.

Line transect survey methods were used for harbor porpoise. When a sighting was made, the observer recorded the angle and distance to the animals relative to the position and direction of the ship. Ocular reticles in the 7x binoculars were used to estimate distance. Estimation of the angle from the trackline of the ship to the position of the animals was aided by protractors mounted in front of the observers. Harbor porpoise sightings and searching information were recorded on the "Research Vessel Harbor Porpoise Sighting and Effort Record". Off-duty personnel were prevented from pointing out marine mammals to the on-duty observers, but such incidental sightings were related to the chief scientist at a latter time. Searching effort was typically terminated when the sea state was greater than Beaufort 5.

Sightings of cetaceans other than harbor porpoise were recorded on the standard SWFC "Research Vessel Marine Mammal Sighting Record" as being off-effort. The first page of this record was filled out by the recorder at the time of the sighting, and the second page was completed by each of the observers who saw the animals. Numerous grey whales (Eschrichtius robustus) were seen, and for expediency, sighting records were not completed for this species. A simple running tally was kept for the number of grey whales seen each day.

Data on ship's position and speed and surface water temperature were recorded automatically on the ship's data logging system when the observers requested this information from the duty officer. This information was transferred to the data coding forms at the end of each day. The ship's position was calculated by an Omega navigation system using a combination of occasional satellite fixes and dead reckoning. Water temperature was measured with a continuous flow-through system. Water depth was relayed directly by the duty officer from the EK-400 depth sounder. Distance from shore was measured on nautical charts after the cruise and entered on the data coding forms.

Helicopter Observations

The helicopter crew consisted of a pilot, a behavior observer, and two data recorders who also functioned as observers as time permitted. The helicopter (Hughes 500D) was equipped with headsets for internal communications. Communication with the vessel was via either marine or aerial VHF radios. The survey team was equipped with hand held tally meters, inclinometers, and tape recorders. Fluorescein dye, packaged in disposable cup, was dropped as a reference mark for sightings. Position information was recorded from a LORAN C system. The helicopter's LORAN was calibrated to that of the ship using the difference between the aerial and ship readings measured while the helicopter hovered at 50-250m over the ship.

During porpoise avoidance studies, the aircraft proceeded ahead of the vessel, approximately three to five miles, and searched approximately 1.5 miles to either side of the vessel's trackline. Upon sighting harbor porpoise, a dye marker was dropped, and the helicopter was positioned so as to head into the wind, while giving the behavior observer the best possible view of the porpoise. Depending on the wind direction and velocity and aircraft weight, the helicopter either slowly circled the sighting at about 20 knots, or alternately hovered and then quickly circled to reposition in the best observational position and altitude. Events, times, altitude, and position information was recorded on the Helicopter Record by the recorder who was in communication with the vessel. At the same time, the second recorder noted behavioral data on the Harbor Porpoise Visibility Record. These data included a time series of observations on the number of harbor porpoise visible at the surface and when animals dove from view.

The helicopter remained with a group of porpoise and monitored behavior as the ship approached and for approximately 15 minutes after the vessel passed. Effort was terminated when either the crew was unable to relocate the animals, the vessel had passed, or the helicopter required fuel. Normal time in the air ranged from 1.75-2.5 hours.

RESULTS

Ship Surveys

The location of harbor porpoise sightings are shown in Fig. 1. The location of other cetacean sightings (excluding gray whales) are given in Table 1. The number of sightings of each species, stratified by sea state at the time of the sighting, is given in Table 2. As on previous cruises, the number of sightings during calm sea conditions are disproportionately greater than the proportion of time spent searching in those conditions (Table 3).

Studies of the relative abundance of porpoise along the 10-, 25-, and 40-fathom isobaths were limited due to rough weather conditions and small boat traffic. In particular, coverage along the 40-fathom isobath was limited to Beaufort sea states of 4 or greater in the Russian River area and was completely unnavigable in Monterey Bay due to large numbers of salmon fishing boats outside of 25 fathoms. The only meaningful comparisons of porpoise density are between the 10- and 25-fathom isobaths for the areas between 38° 17' and 38° 29'N (Russian River) and between 36° 47' and 36° 57'N (Monterey Bay) (Table 4). These two areas show opposite trends: in the Russian River area porpoise density is apparently higher along the 25-fathom isobath, and in Monterey Bay density appears higher along the 10-fathom isobath. These data will be added to other such data that have been collected on previous surveys to develop a model for the depth distribution of porpoise.

During periods when two teams of observers were making independent sightings, a total of 103 different groups of harbor porpoise were spotted. Of these, 85 were sighted only by the 5 principle observers on top of the pilot house, 6 were sighted only by the 3 "monitor" observers stationed on the pilot house deck, and 12 were sighted by both groups. Of the 103 sightings, 33 were estimated to be within 100m perpendicular distance from the transect line (calculated from observer's estimates of angles and distances to the groups). Of these 33 groups that were close to the track line, 20 were detected only by the principal observers, 3 were detected only by the monitor observers, and 10 were detected by both teams. These data will be used to estimate the probability that a group of trackline porpoise would be missed by the typical observer teams. Although their effort was not quantified, off-duty observers and ship personnel made 4 additional porpoise sightings which were missed by both teams of on-duty observers. These data indicate that at least some groups of animals near the trackline are missed during harbor porpoise surveys.

Helicopter Observations

The helicopter team made 32 sightings of harbor porpoise during 31.1 hours of flying. Of this time, approximately 3.0 hours was in transit to and from the airport or other fueling location. Of the 32 sightings, 12 were not relocated after the initial sighting. Ten others were relocated, but the animals were not observed long enough to obtain either surfacing interval or vessel reaction data. Ten groups provided useful data on surfacing interval, and 6 of these also yielded data on vessel avoidance.

The percentage of time that porpoise were visible from the air averaged 24.4% for the 10 groups, but this varied considerably between groups (Table 5). The typical surfacing pattern consisted of a series of surfacings followed by a dive. Average durations for surfacing series and dives are given in Table 6. The mean time at the surface was 0.6 minutes, although in one instance a group was observed at the surface for 1.5 minutes. When sighting conditions were good, the groups were always visible from the air during a surfacing series. Porpoise did not appear to react to the helicopter; some groups were observed relatively motionless at the surface for long periods of time without any visible reaction to the sound of the turbine engines or blades.

Data on porpoise avoidance of the research vessel were limited to transects past 6 groups of animals. Plots of vessel tracks and helicopter positions are given for these 6 transects (Figs 2-7). The helicopter was usually 200-300m lateral distance from the porpoise groups in order to best view them. Therefore, the helicopter positions are only roughly equivalent to the positions of the porpoise groups. On Track 1 (Fig. 2), the helicopter observers lost the group before the ship approached within 1 n.m. Track 2 (Fig. 3) passed directly through the original position of the group without any course changes. On Track 3 (Fig. 4), the helicopter stayed with the group until it had passed abeam of the vessel. On Track 4 (Fig. 5), the ship was diverted to pass close to the group and, after it was well past the group, was diverted again to pass near the animals a second time. On Track 5 (Fig. 6), the ship was again diverted to pass directly through the original position of the animals. On Track 6 (Fig. 7), observers on the helicopter again lost the animals before the ship had past by them. Observers on the vessel also sighted the animals during Tracks 4, 5, and 6 (although only during the first pass on track 4). On the other two tracks, the nearest approach to the animals was never closer than 1km. Only on Track 5 was a distinct behavioral change noted in the porpoise in response to the ship. In that case, the group was observed to react by rapidly moving perpendicular to the path of the vessel and then parallel and in the opposite direction of the vessel. Although this sample is very limited, movement in response to the survey vessel appears limited to within 1km of the vessel and, when it occurs, animals do not travel far from their original positions.

RECOMMENDATIONS FOR FUTURE SURVEYS

Information gained on this survey is relevant to planning future surveys for harbor porpoise. Results from using two teams of observers have shown that groups of porpoise can appear relatively close to the vessel and be missed by the principal observers. Part of the reason for this may be that the porpoise appear beneath the field of view of observers using binoculars and are missed by the recorder (whose duty it is to search this area with unaided eyes) because that person is busy with the task of recording data. For this reason, a sixth observation position should be created whose sole duty is to observe the immediate area within 100m of the bow of the ship. Additional analysis is required to evaluate whether future surveys should include two teams of observers searching independently.

This and the previous cruise have shown how difficult it is to get data to adequately model the inshore/offshore distribution of harbor porpoise. Data collected from different areas are quite variable and seem to indicate different depth preferences in different geographic areas. A good model of distribution should therefore include data for the entire coastline. Instead of surveying just the 10-fathom isobath and extrapolating density using a model of inshore/offshore distribution, a different approach should be used on the next survey. If survey lines were set up to diagonally cover the area between the 10- and 50-fathom isobaths, most harbor porpoise habitat would be included. If that coverage were uniform, a model of inshore/offshore distribution would not be required, except for the area inside of 10 fathoms and outside of 50 fathoms. A similar approach may be desired on future aerial surveys as well.

Although a helicopter proved useful in collecting data on surfacing intervals and porpoise avoidance behavior, its utility was limited by several factors: 1) When fuel tanks were full, the helicopter was unable to maintain altitude while hovering, thus it was necessary to circle periodically to gain altitude. Porpoise surfacings could be missed during such times. 2) Flight times were limited to a maximum of only 2.5 hours. 3) Downward visibility from the helicopter was limited by flotation pontoons on its landing struts, thus requiring the helicopter be positioned some distance from the animals being observed and limiting accuracy in estimating porpoise position. 4) Porpoise could be tracked only under good sighting conditions (low wind, clear skies, and little haze); such conditions were rare during this study.

If a helicopter is used in future studies of harbor porpoise, several changes could make this platform more useful. The ability to hover without losing altitude is critical. A more powerful helicopter would be desired; however, better performance might also be obtained by taking only one data recorder and thus reducing total weight. This might be accomplished if an automatic position recording system were used and if communication with the ship were minimized. Longer flight times are also desired, but this would require auxiliary fuel tanks (assuming the same type of helicopter were used again). The additional weight of this fuel would, however, reduce the ability to hover. Downward visibility is also important, and in this study it was reduced greatly by the inflated pontoons. This could be improved by using pontoons that are inflated only in cases of emergency. Since porpoise reaction to vessels only appears to occur within 1.0km of the vessel, future avoidance studies would require some means of determining porpoise position when closer than this distance from the ship. Finally, when planning future aerial work on harbor porpoise, a more appropriate season should be considered to minimize the amount of time lost due to poor weather.

Prepared by: Jay Barlow, Chief Scientist
Chuck Oliver
Stephanie Sexton

II. DOVER SOLE COLLECTION

OBJECTIVES:

1. To study reproductive condition of Dover sole collected from 100-600 fathoms bottom depths in the Pt. Sur-Pt. Conception area.

2. To obtain live Dover sole to establish a brood stock in the Southwest Fisheries Center aquarium.

PROCEDURES:

1. Otter trawls were conducted nightly May 2-4 after finishing daily harbor porpoise survey operations. Bottom trawls were made with a 400 Eastern otter trawl using 5x7' trawl doors. Trawls of 30 to 45 minutes duration were made along isobaths. Trawl locations were examined with the echosounder prior to setting the nets to detect uneven bottom topography and large obstructions. Subsamples of Dover sole from each catch were measured and sexed. The female ovaries were removed, preserved in formalin and the bodies frozen. Other fish species were identified and counted. Some incidental invertebrates and fish were placed in live tanks for transport to the Scripps Aquarium.

2. One trawl of 10 minutes duration was made along the 200 fathom isobath. Live Dover sole were placed in a live tank containing 6^{o} seawater.

RESULTS:

1. Four successful trawls were made at depths ranging from 180-540 fathoms (Table 7). Two of three trawls attempted in the 300-400 fathom range did not maintain bottom contact. Only 1 Dover sole specimen contained ovaries with ripe eggs indicating that most females had completed spawning. Dover sole and rex sole were co-dominant in the 100 fathom trawls and Sebastolobus dominated the 300-500 fathom trawls. Many gravid female rex sole were observed in trawl #3 and 25 specimens were frozen for later analysis.

2. Live Dover sole and a few live sablefish were collected and placed in a live tank containing chilled 6^{o} seawater. The preliminary results indicate a higher survival rate than the March collection of Dover sole.

INCIDENTS & MALFUNCTIONS: On May 4 trawl 6 was delayed at 1840 hours, when the doors were crossed. The problem was corrected and the trawl was re-deployed at 2017 hours.

Prepared by: William C. Flerx

DISPOSITION OF DATA: Marine mammal sighting records were given to the Marine Mammal Division data management group. Data on helicopter observations were retained by the chief scientist.

Trawl data, preserved/frozen Dover sole - Eric Lynn, NMFS, SWFC
Live Dover sole - Roger Leong, NMFS, SWFC
Remainder of catch was returned to the sea.

Approved by ______________________ 6/13/86
Jay Barlow — Date
Chief Scientist

Approved by Izadore Barrett 6/20/86
Izadore Barrett — Date
Director, F/SWC

Distribution: see attached list.

Appendix 2AF. Cruise report for SWFSC Cruise 0970. (Continued)

Table 1. Time and location of cetacean sightings, excluding *Phocoena* and *Eschrichtius*. Sea state refers to the estimated Beaufort number at the time of the sighting. Group size is the median of the independent estimates by each observer who recorded group size.

DATE	TIME	SPECIES	LATITUDE	LONGITUDE	SEA STATE	EST. GROUP SIZE
4/25	0656	unidentified small cetacean	38° 31'	123° 09'	3	2
4/27	1623	unidentified small cetacean	37° 57'	122° 55'	3	1
	1649	unidentified small cetacean	37° 55'	122° 51'	4	1
4/29	0840	*Phocoenoides dalli*	36° 48'	121° 48'	3	5
	1259	*Balaenoptera acutorostrata*	36° 53'	121° 58'	3	1
	1334	*Phocoenoides dalli*	36° 49'	121° 51'	4	5
	1347	*Phocoenoides dalli*	36° 47'	121° 49'	5	3
4/30	0736	*Balaenoptera acutorostrata*	36° 53'	121° 54'	1	1
	0918	*Balaenoptera acutorostrata*	36° 54'	122° 01'	2	1
5/02	1600	*Grampus griseus*	36° 41'	122° 04'	3	43
5/03	0649	*Grampus griseus*	36° 32'	122° 02'	2	4
	0910	*Balaenoptera acutorostrata*	36° 18'	121° 55'	1	1
	0913	*Balaenoptera acutorostrata*	36° 18'	121° 55'	1	1
	0920	*Balaenoptera acutorostrata*	36° 17'	121° 54'	1	1
	1159	*Balaenoptera acutorostrata*	36° 07'	121° 39'	1	1
	1435	*Balaenoptera acutorostrata*	35° 49'	121° 25'	1	1
5/04	0938	*Balaenoptera acutorostrata*	35° 20'	120° 53'	1	1
	1730	*Delphinus delphis*	34° 20'	120° 10'	6	10
5/05	0730	*Tursiops truncatus*	33° 21'	118° 15'	2	8
	1027	*Delphinus delphis*	33° 18'	118° 12'	1	177

Table 2. Number of cetacean sightings stratified by sea state at the time of the sighting.

Species	Beaufort Sea State 0	1	2	3	4	5	6	Total
Balaenoptera acutorostrata		7	1	1				9
Delphinus delphis		1					1	2
Phocoenoides dalli				1	1	1		3
Phocoena phocoena	1	106	46	33	13	1		200
Tursiops truncatus			1					1
unidentified small cetacean				2	1			3
Eschrichtius robustus								77

Table 3. Percentage of *Phocoena* sightings made at various sea states, and percentage of searching time spent at those sea states.

Beaufort Sea State	Percentage of *Phocoena* sightings	Percentage of Searching effort
0	0.5 %	0.1 %
1	53.0	30.6
2	23.0	24.6
3	16.5	22.1
4	6.5	18.4
5	0.5	4.0
6	–	0.2
TOTAL	100.0	100.0

Table 4. Relative abundance of harbor porpoise for transects at 10- and 25-fathoms at two different locations. Number of sightings, number of miles searched and number of porpoise groups per mile are stratified by their position relative to the vessel and the shore. For the Russian River area, sea states of 2 and 3 were pooled, and mean Beaufort was calculated as the average of the sea states experienced during the transects. For Monterey Bay, sample sizes were sufficient to report sighting rates at three different sea states. Searching effort and sightings at Beaufort sea states 4 and higher were not included.

	Number of Sightings			Nautical	Sightings	
	Inshore	Trackline	Offshore	Miles	per Mile	Beaufort
Russian River, CA						
10-fathoms	0	0	0	13.7	0.00	2.85
25-fathoms	5	2	3	18.2	0.55	3.00
Monterey Bay, CA						
10-fathoms	28	6	27	45.1	1.35	1
25-fathoms	5	2	4	9.0	1.22	1
10-fathoms	18	2	19	53.0	0.74	2
25-fathoms	0	0	2	12.9	0.16	2
10-fathoms	1	0	0	21.1	0.05	3
25-fathoms	1	1	7	19.1	0.47	3

Table 5. Percent time visible from the air and percent time diving for 10 groups of harbor porpoise observed from helicopter. Number of porpoise within a group varied for some sightings. Data were rated using a subjective quality code (below).

Date	Initial Sighting Time	Number of Porpoise	Quality Code	Total Time Observed (minutes)	% of Time Visible	% of Time Diving
86/04/27	0803	1	3	9.85	17	83
86/04/27	0817	2	2	17.32	20	80
86/04/27	1130	3-5	1	27.39	27	73
86/04/30	0757	1-2	4	12.33	9	91
86/04/30	0843	1-4	1	10.33	25	75
86/04/30	1045	1-3	2	18.75	30	70
86/04/30	1152	3	4	9.64	13	87
86/05/02	0900	2-5	1	42.25	44	56
86/05/02	1055	2-3	2	8.78	35	65
86/05/02	1128	2	3	6.30	24	76
				Mean	24.4	75.6
				S.E.	3.3	3.3

Quality code: 1 - good for surfacing interval and vessel reaction.
2 - fair for surfacing interval and vessel reaction.
3 - good for surfacing interval only.
4 - fair for surfacing interval only.

Table 6. Mean duration of dives and surfacing series for 10 groups of porpoise observed from the helicopter. Mean values for all 10 groups are calculated without weightings.

Date	Time of Initial Sighting	Duration of Dives (minutes)	Duration of Surfacing Series (minutes)	# Surfacing Series
4/27/86	0803	1.63	0.34	5
4/27/86	0817	3.64	0.94	4
4/27/86	1130	2.47	0.91	7
4/30/86	0757	2.81	0.27	4
4/30/86	0843	1.94	0.65	4
4/30/86	1045	1.32	0.58	10
4/30/86	1152	2.09	0.32	4
5/02/86	0900	0.93	0.73	25
5/02/86	1055	1.13	0.60	5
5/02/86	1128	1.59	0.51	3
	Average	1.955	0.585	
	S.E.	0.263	0.074	

Appendix 2AF. Cruise report for SWFSC Cruise 0970. (Continued)

Table 7. Results of dover sole trawls.

Trawl #	1	2	3	4	5	6
Depth (F)	535–540	336–356	175–180	175–180	310–315	304–308
Wire Out (M)	1250	960	680	680	900	880–900
SPECIES						
Dover sole	71	-0-	364	71*	10	
Rex sole		"water haul"	365	102		
English sole		"	2	1		
Petrale sole		"	1			
Merluccius		"	7	2		
Anoplopoma	36	"	8	3	18	
Sebastolobus	320	"	49	7	188	
Sebastes		"	108	13	18	
Grenadiers	37	"			6	
Ratfish		"	11	3		
Snailfish	1	"			2	
Slickheads	14	"			10	
Eelpouts	3	"	56		5	
Spiny dogfish		"	9			
Cat sharks	7	"	41	14	4	100*
Big skate		"	16	4	3	
Black skate		"	2			
Sandpaper skate		"	23	3		

* Placed in live tank.

Appendix 2AF. Cruise report for SWFSC Cruise 0970. (Continued)

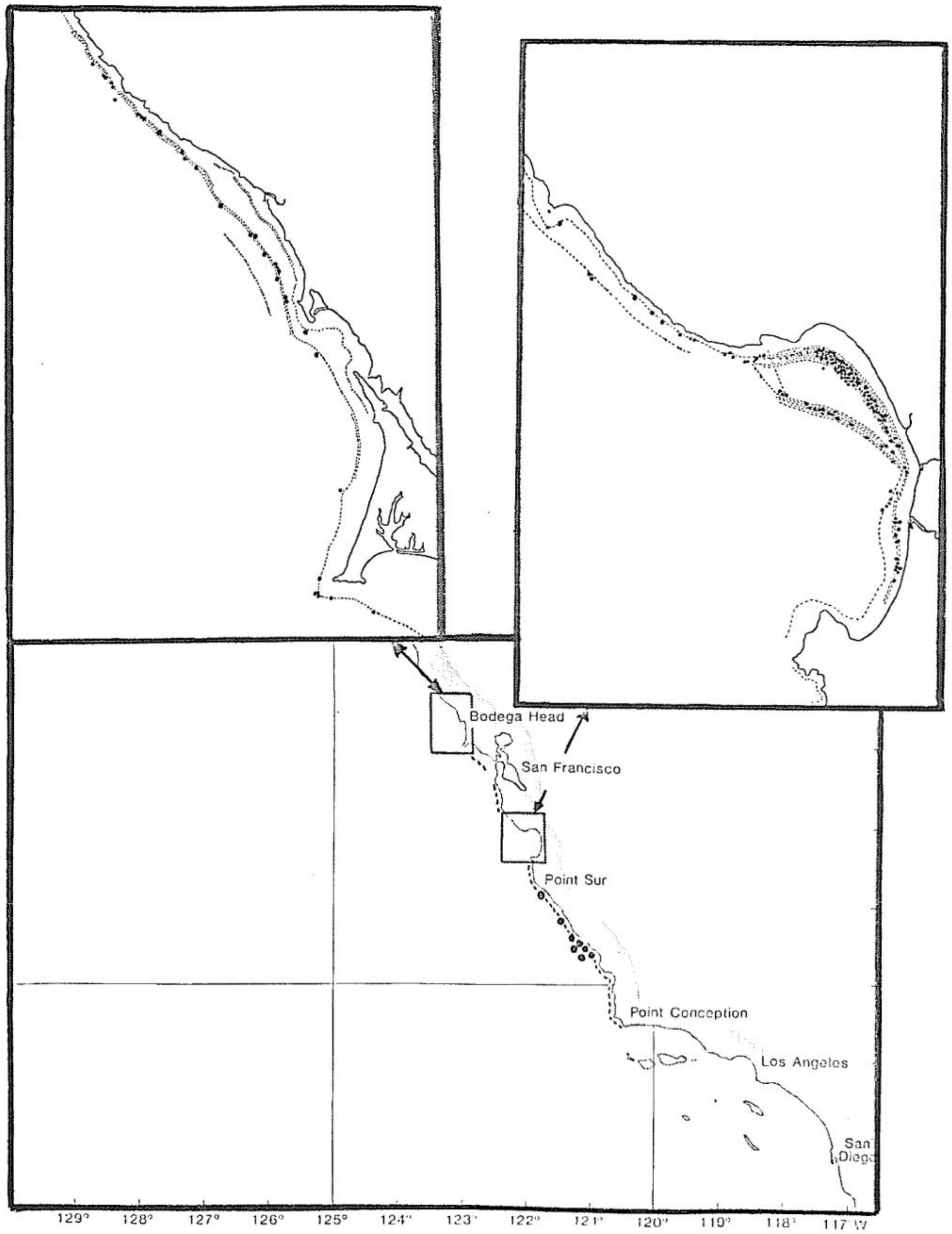
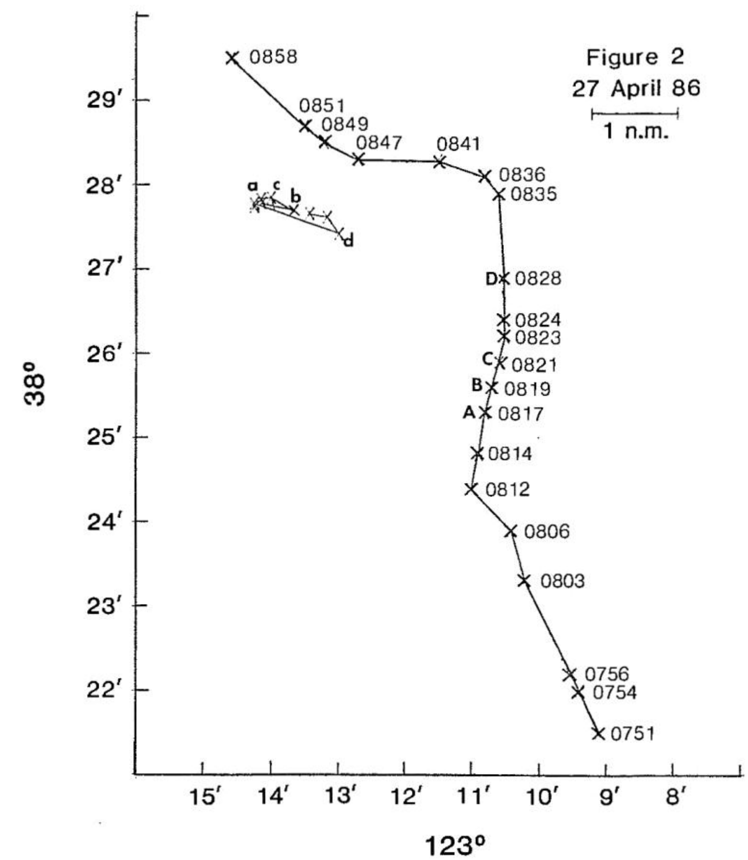


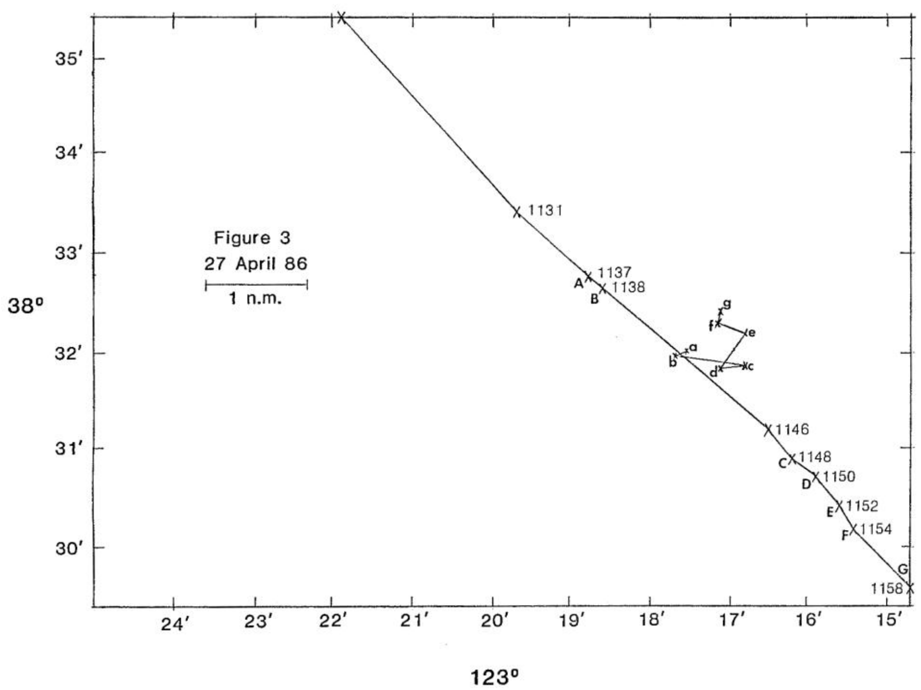
Figure 1. Cruise tracks (---) and locations of harbor porpoise sightings (•) made during marine mammal surveys.

Appendix 2AF. Cruise report for SWFSC Cruise 0970. (Continued)

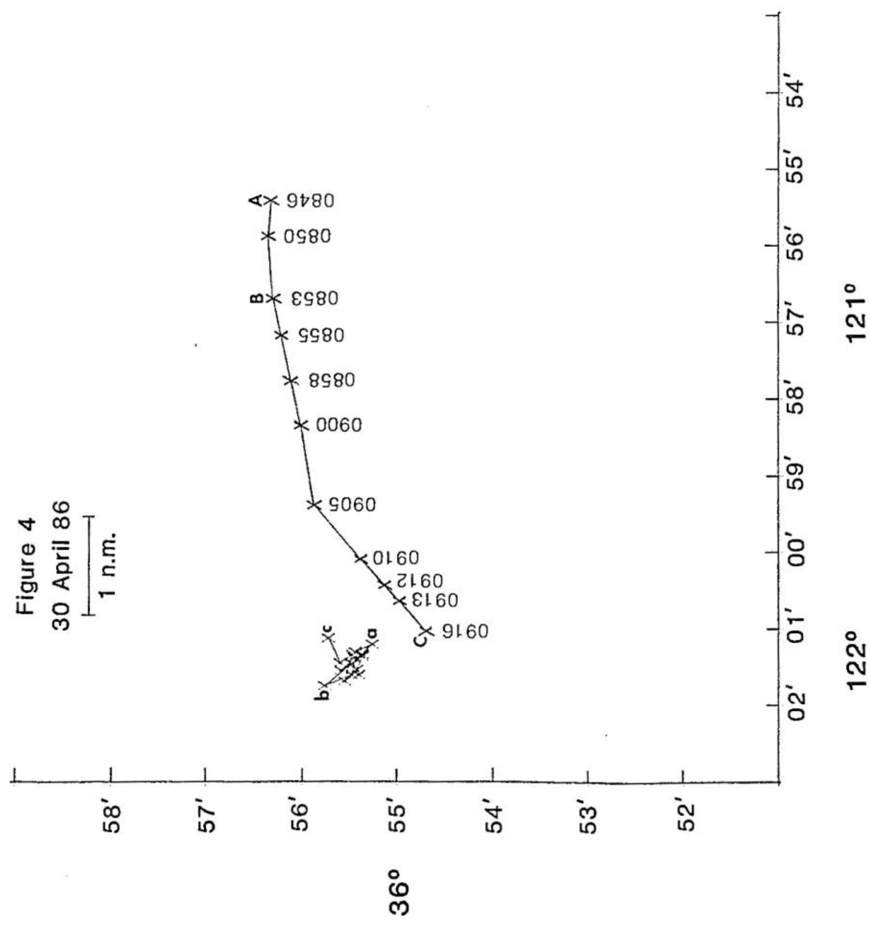


Figures 2-7. Ship and helicopter positions during harbor porpoise avoidance experiments. Ship position fixes are marked with an X (and capital letters) and are accompanied by time marks. Helicopter positions correspond approximately to porpoise position and are marked by an X (and lower case letters). Like letters (eg. A and a) correspond to position fixes made at the same time. Circled positions indicate the ship's location at the time shipboard observers first sighted the porpoise group that was being followed by the helicopter. With the exception of Fig. 3 (which is based on radar angles and distances), helicopter positions are based on LORAN readings.

Appendix 2AF. Cruise report for SWFSC Cruise 0970. (Continued)



Appendix 2AF. Cruise report for SWFSC Cruise 0970. (Continued)



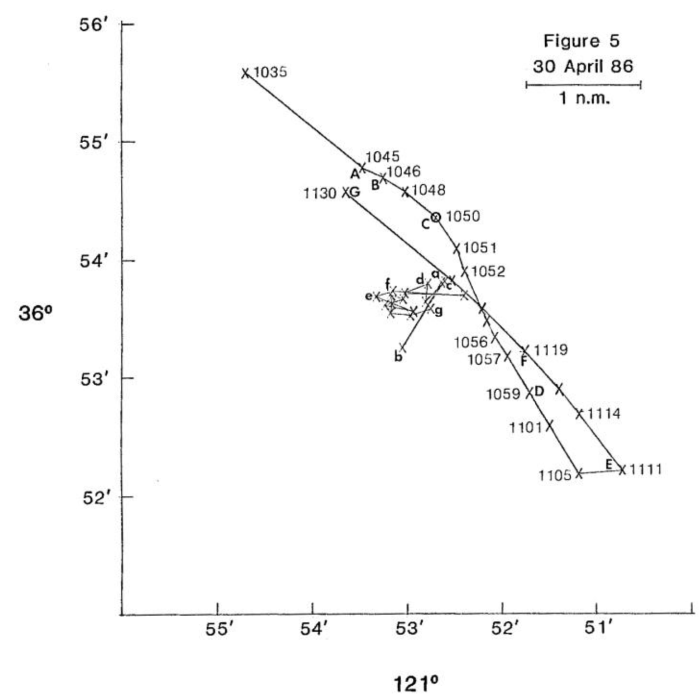


Figure 5
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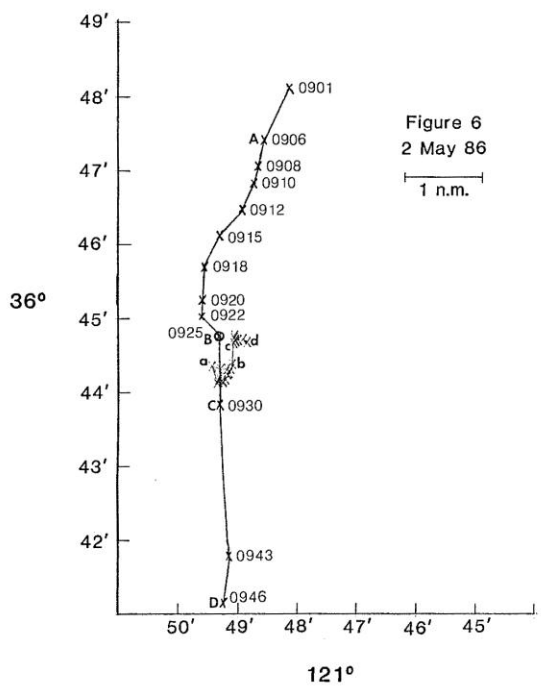
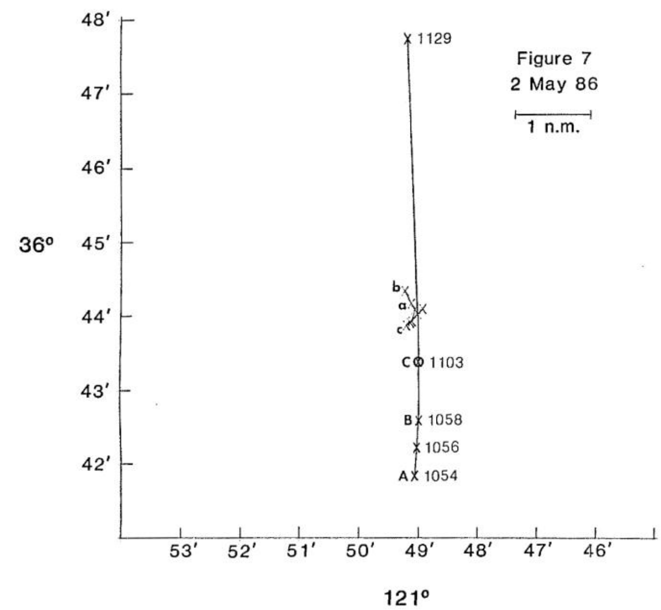
Appendix 2AF. Cruise report for SWFSC Cruise 0970. (Continued)



Appendix 2AF. Cruise report for SWFSC Cruise 0970. (Continued)



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Appendix 2AF. Cruise report for SWFSC Cruise 0970. (Continued)

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